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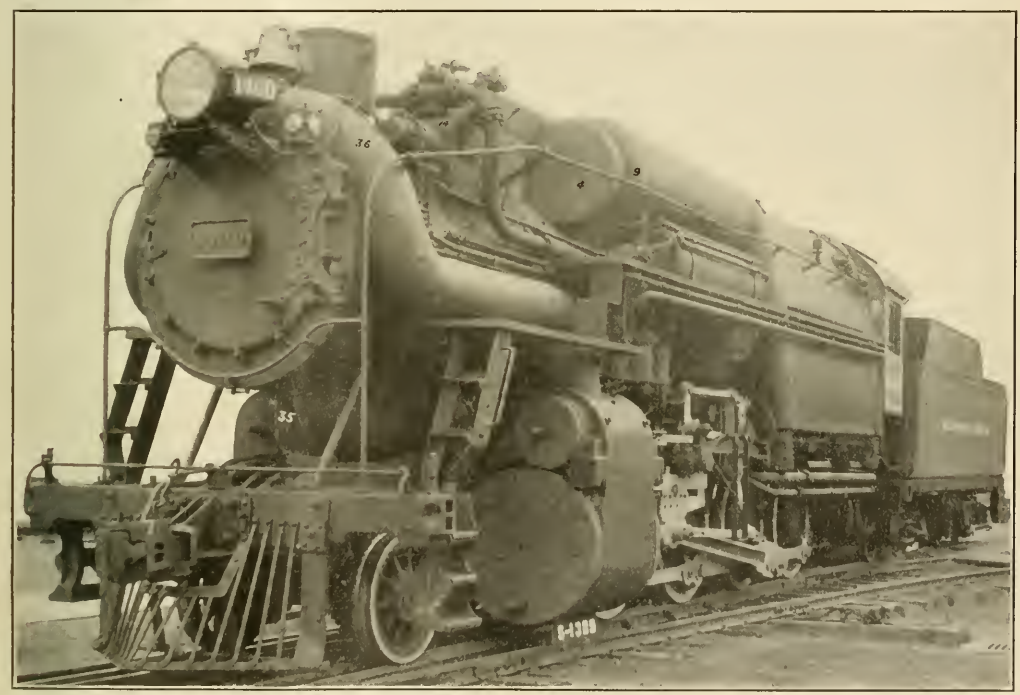
The Locomotive Horatio Allen

Some of the Novel Details of the New High Presssure Consolidation Locomotive Built for the Delaware & Hudson Co.

In his address to the guests assembled at the christening of the high pressure locomotive, the Horatio Allen, an account of which was published in RAILWAY AND LOCOMOTIVE ENGINEERING for December 1924, Mr. John E. Muhlfeld the designer, gave a brief outline of the genesis of this machine, as well as some interesting data regarding the engine itself.

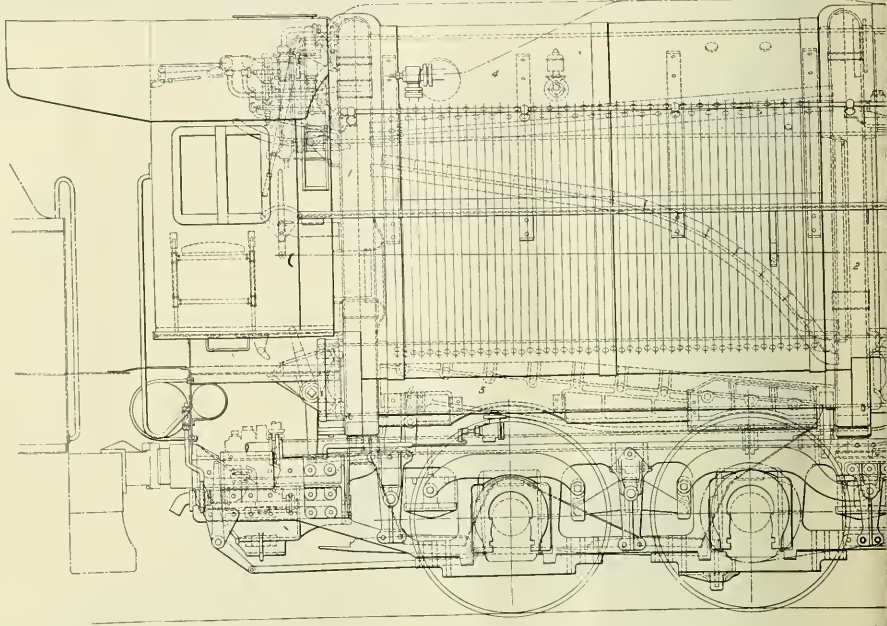
It was back in 1901 when he was superintendent of machinery and rolling stock of the Canadian Government Railways that he designed a high powered cross-compound consolidation locomotive for fast heavy tonnage service. This locomotive was designed for a boiler pressure of 250 lbs. per sq. in. It had 63 in. diameter driving wheels and cylinders of 21 in. and 36 in. diameter with a piston stroke of 30 in. The weight on the driving wheels, in working order, was to have been 188,000 lbs. with a tractive effort, when working compound of 40,000 lbs. and when working simple of 48,000 lbs.



New High Pressure Consolidation Type Locomotive of the Delaware & Hudson Co.

The construction of this locomotive was authorized but was never built, but now, the Horatio Allen is a somewhat enlarged and improved edition of that engine which was proposed about twenty-two years ago.

Coming now to the Horatio Allen, Mr. Muhlfeld said that it was during the fall of 1919 that, in a discussion as to the increasing fuel costs of the Kansas City Southern, "I was explaining as to what I thought should be done in the way of modernizing existing locomotives, the boiler, in direct contact with water tubes and the radiant heat action on the same, in combination with improved circulation of the water and the more effective combustion and heat utilization, as compared with the ordinary radial stayed or Belpaire type of firebox either



Side Elevation of New High Pressure Consolid

and that in new construction the utilization of higher steam pressures and cross compounding should be given full consideration, along the lines of a new design I was working upon. At this juncture Mr. L. F. Loree walked in and the discussion was reopened, with the result that he asked me to send him a memorandum of what I proposed to do. The result of this interview was his authorization of the construction of the Horatio Allen.

"The Horatio Allen has been designed in order to determine as to what can be accomplished in the way of a better production and utilization of fuel heat and by means of a higher steam pressure and the greater use of its expansion properties, in combination with the development of maximum hauling power in the most simplified form of a modern steam locomotive, consisting of two cylinders and four pairs of driving wheels.

"It is calculated that, by the use of steam of 350 lbs. per sq. in. pressure in double expansion cylinders, the saving in fuel consumption per unit of work done by the locomotive, when working in compound gear as compared with the ordinary single cylinder locomotive, will be:

"First: The gain from increasing the steam pressure from 200 to 350 lbs. per sq. in. will represent about 15 per cent less fuel consumed per drawbar horsepower hour.

"Second: The gain through the double expansion of the steam will represent about 17 per cent less fuel consumed per drawbar horsepower hour.

"Third: The gain from generating 75 per cent, instead of 40 per cent of the steam at the firebox end of with or without combustion chamber, syphons or like equipment, will represent about 12 per cent less fuel consumed per drawbar horsepower hour.

"The total calculated saving, when working compound, therefore approximates 39 per cent of the fuel consumed by the ordinary single expansion steam locomotive, per drawbar horsepower hour.

"In order to assist in accomplishing these results

Interior of Firebox

through the use of 350 lbs. steam pressure, a substantially different type of locomotive boiler has been designed, the particular idea being to eliminate the usual stayed type of flat sheet firebox sides and crownsheet and water legs, in combination with their sluggish circulation, and substitute self-supporting cylindrical containers, in line with stationary and marine practice, and this has been accomplished in a very satisfactory manner.

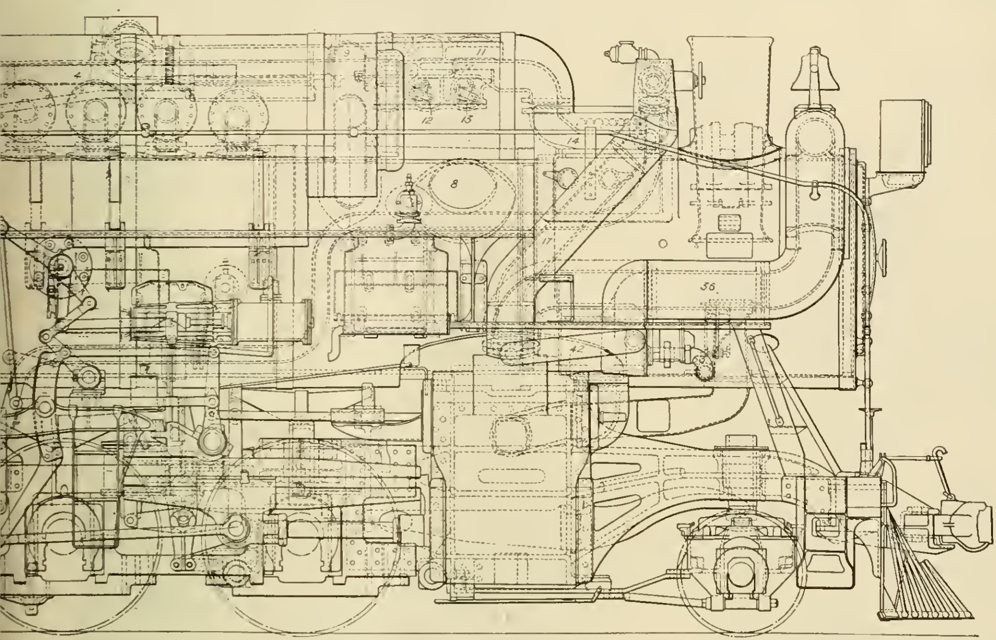
"A peculiar feature of the boiler design is the firebox, which contains almost 1200 sq. ft. of heating surface as compared with from 400 to 450 sq. ft. in the largest combined fireboxes and combustion chambers of the usual locomotive boilers.

"In the latter the firebox heating surface generally represents from 5 to 10 per cent of the total evaporation surface, whereas, in the Horatio Allen, it represents 37 per cent of the total. This makes it possible to take greater advantage of the radiant heat of combustion for evaporation purposes and, as firebox heating surface ordinarily has about five times more steam making capacity than that of the fire tubes or flues, it provides for the production of about 75 instead of 40 per cent of the total steam at the firebox end of the boiler, where it can be most effectively and economically generated."

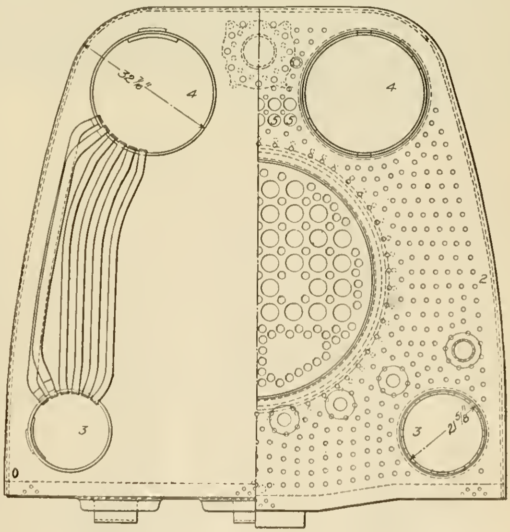
Taking up the construction of the boiler in detail, and referring to the illustrations, it will be seen that the front and back walls of the firebox are formed by two water legs 1 and 2, which are made of flat plates and stayed in the usual manner. The front head is cut away and flanged in order to receive the circular back tubesheet.

It would have been a simpler and easier mode of construction to have made the back sheet of this header in one flat piece. The reason for adopting the method of construction shown, was for the purpose of facilitating repairs, in case of the cracking of the bridges; it being easier to replace the circular tubesheet than the whole of the inner sheet.

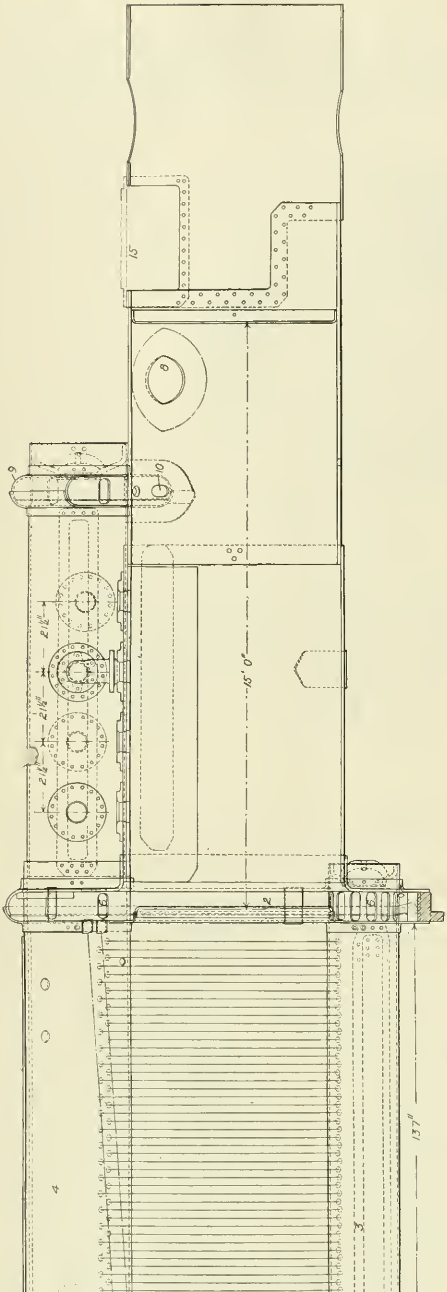
The firesheets of the front and back legs are ½ in. and 7/16 in. thick respectively, while the outer sheets are ⅞ in. and ⅝ in. The two heads or waterlegs are set 137 in. apart and are held together by four cylindrical drums, 3 and 4, two being at the top and two at the bottom, and by ten 3 in. outside diameter tubes at 5. These tubes are expanded into the inner sheets of the two legs, and opposite them in the outer sheets there are holes for their insertion and cleaning into which plugs are screwed.



...e Locomotive of the Delaware & Hudson Co.



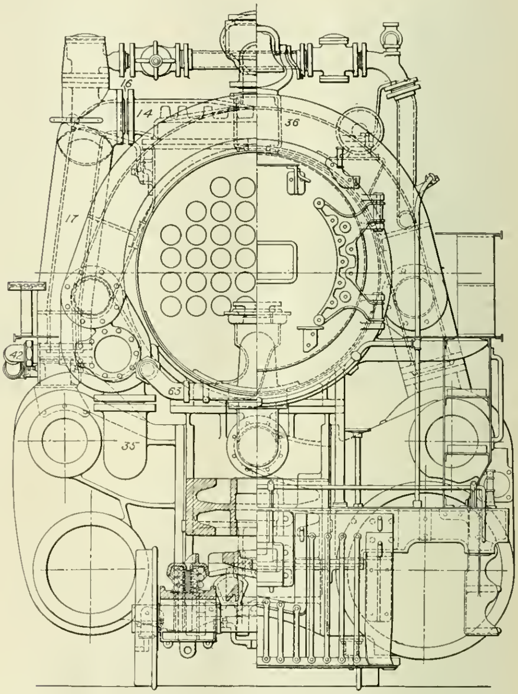
Half Sections Through Firebox Showing Circulating Tubes, Drums and Back Tubesheet.



Longitudinal Section of Boiler

Both sheets forming the heads are flanged outwardly and the drums pass through the water space and are rivetted to each of the flanges. Where they pass through the water legs they are cut away with a number of oblong holes as indicated at 6, in order to open communication between their interiors and the water legs. The lower drums are 21⅝ in. outside diameter and the upper ones are 32 7/16 in. The lower and upper drums are connected by 6 rows of vertical water tubes that are expanded into each of them. They are spaced 2⅞ in. apart where they enter the drums and, counting longitudinally, there are fifty-one tubes in each row or 306 of the water circulating tubes on each side of the firebox.

These water tubes are of solid drawn seamless steel and are so arranged as to permit the use of a mechanical



Front Elevation of Locomotive

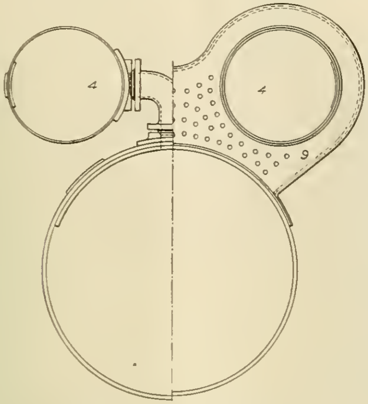
cleaner. The first and second rows from the outside are 2½ in. outside diameter; the third and fourth rows are 2 in. outside diameter and all four are of No. 7 Birmingham wire gauge thickness. The fifth and sixth rows are also 2 in. outside diameter but of No. 6 thickness. The sixth row is the one next to the fire.

The brick arch is carried by six 3½ in. outside diameter tubes, having an upward curvature as shown in the line illustration of the boiler and the reproduction of the photograph of the interior of the firebox. The ends of the two lower and upper drums are closed by manhole plates held in place by a yoke and bolts.

The upper drums are extended forward to a point 37⅛ in. back of the outside face of the front tubesheet, by drums 30 in. outside diameter and ⅝ in. thick.

These drums are connected to the boiler shell by two elbow connections to each. These are spaced alternately 21½ in. apart, and the pipes enter into 6¼ in. diameter holes in the drums. The elbows are cast with the flanges and are connected at each end with spherical ground joints, of the ordinary type, to flanges rivetted to the drums and shell.

The shell is made up to two courses of steel 1 1/16 in. thick. The back course is 64 in. inside diameter and is double rivetted to the inside of the projecting flange of



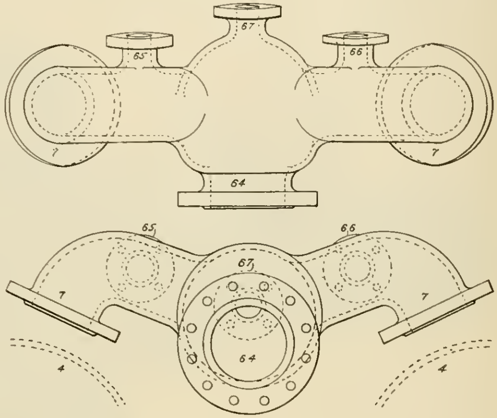
Section of Shell Showing Front Extension of Upper Drum and Elevation of Supplementary Header

the front waterleg of the firebox, and to the outside of the front course which is, therefore, 64 in. outside diameter. The thickness of the back tubesheet is ½ in and that of the front ⅝ in. The distance between their two outside faces is 15 ft. On the left hand side of the shell just in front of the extension drums at 8, there is a manhole 15 in. in diameter through which access is obtained to the interior of the shell.

The front ends of the extension drums are supported by a secondary water or, more properly, steam leg 9 in. across on the inside, which is made up of two flanged sheets of ½ in. steel rivetted to the top of the shell and through which the extension drums pass and to which they are rivetted in the same manner as the main drums to the water legs at the rear. In order to give the steam access to this leg from the shell the latter is perforated with four holes, 10.

The boiler contains 145 two-inch fire tubes and 42 five-inch superheater flues. Steam is taken from a drypipe casting of the form shown in the engraving. The two flanges, 7, are bolted by means of a ground ball point to the two upper drums, 4, at a point about mid way of the length of the extensions. Steam for the cylinders is drawn from this casting into the outside drypipe through the flanged opening 64, and for the right and left hand injectors through the openings 65 and 66 respectively; while steam for the turret in the cab is taken at the connection 67.

This raises the point of steam exit to the maximum possible height above the steam generating surface. But in order to reduce the possibility of lifting water to a minimum, a perforated pipe 6 in. in diameter and 6 ft. 7 in. long is suspended in each drum with a center opening directly beneath the drypipe casting. This pipe is closed at each end, and, thus, by means of the perforations draws the steam from a long extent of surface, thus insuring an even flow of steam. Then in order to still further guard against the delivery of wet steam to the superheater, the drypipe is fitted with a centrifugal separator of the same type as that described in connection



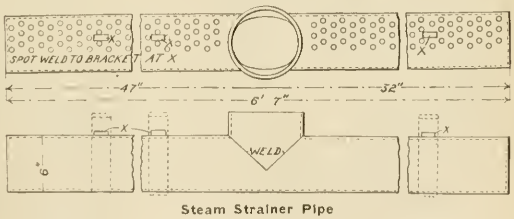
Steam Supply Yoke Casting

with the Mallet locomotive of the Kansas City Southern Railway in the September 1924 issue of RAILWAY AND LOCOMOTIVE ENGINEERING. This has been found to be so effective that, when the drip valve of the separator


Boiler of High Pressure Locomotive

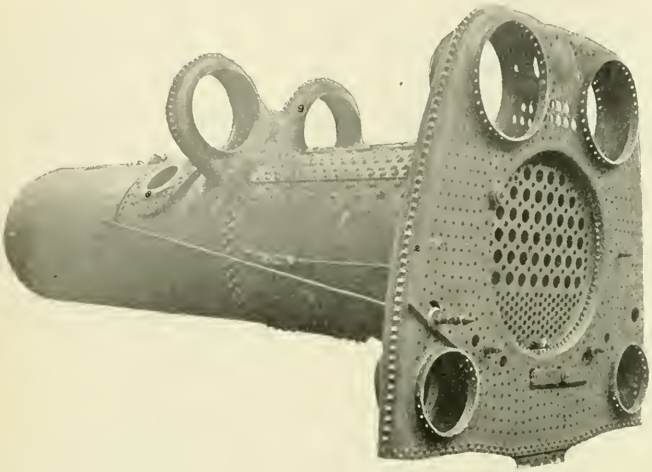
is opened after the engine has been in service there is no discharge of water.

The drypipe delivers the steam directly into the throttle valve casting 11. In this there are two throttle valves whose operating levers are indicated by the dotted lines 12 and 13 of the side elevation of the front end. This casing is set on top of the boiler in front of the steam drums and is readily accessible at all times.



Steam Strainer Pipe

From the throttle casing the steam flows out at the front end into an elbow that turns downward and is connected by a ground ball joint of the ordinary type to the superheater header which is set outside on top of the smokebox and back of the smokestack as shown at 14. It is located just back of the stack and a wide opening at 15 in the smokebox measuring 25½ in. longi-



Shell and Water Leg of Boiler of High Pressure Locomotive

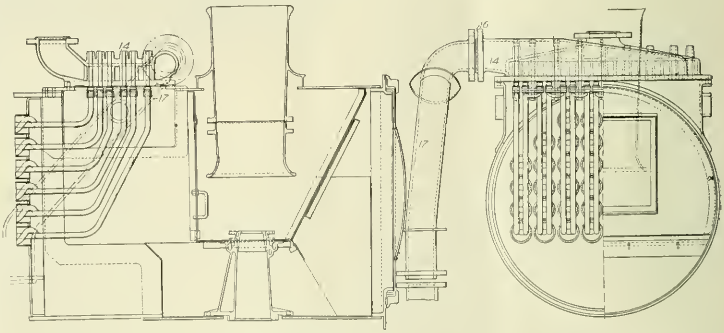
tudinally by 55 in. on the chord of the smokebox is cut to admit the nest of superheater units. There are six rows of these units fore and aft and eight across the boiler arranged, as shown in the engraving, to drop down and enter the 42 superheater flues. As indicated by the drawing, showing the entrance of the superheater unit into the flue, the saturated steam pipe is bent into helical form about the superheated steam pipe while the latter is straight from end to end. This has the triple advantage of increasing the superheating surface; of relieving the expansion stresses at the return bend, due to the differences of temperatures of the two pipes, and of giving the inflowing saturated steam a whirling motion, by which the centrifugal action breaks up any core of moisture that may exist and by projecting it against the walls of the piping causes it to be surely evaporated and superheated. There are but two pipes in each unit, and they are carried back to within 12 in. of the back tubesheet which is somewhat nearer than ordinary practice. Provision is made against burning the return bends, when steam is shut off, by causing the steam from the relief valve to pass through the superheater, thus maintaining a circulation before it enters the cylinders. This arrangement of superheater is designed to produce a total steam temperature of 600 degrees Fahr. which will make about 165 degrees of actual superheat, the superheat being intentionally reduced until it is known as to what effect temperature coupled with the unusual pressure will have on the valves and cylinders. And again it is desired to reduce the loss in pressure between the boiler and the high pressure cylinder and avoid the discharging of any superheat into the atmosphere with the low pressure exhaust.

The front view of the superheater shows the construction of the header. The steam entering at the center flows out to the units on each side, and then, when it is delivered back to the header, the sectional area of the latter increases from the left to the right hand side of the engine, reaching its maximum at the point of connection of the steam pipe at 16 where there is the usual ground ball joint. The steam pipe 17 leading to the high pressure cylinders on the right hand side, has a diameter of 7½ in.

We now come to one of the novelties of the construction and that is that of the saddle and front end of the frames. The back portion of the frame is of the ordinary bar type. It has a uniform width of 5½ in. and a depth over the second and third pedestals of 8½ in. At the front pedestal it has a total depth of 13¼ in. As indicated the slab portion which ends back of the cylinders, is of the full width of the frame, and with it the frame ends. Instead of being extended forward to the front bumper by means of a bar or slab construction, it is bolted by thirty-two 1¼ in. diameter bolts to a backwardly projecting lug cast on the saddle at 18.

The saddle is a steel casting that has not only these two rearwardly projecting lugs, 5 in. thick and 37 in. deep, to which the frames are bolted, but it is extended forward with a ribbed structure, that takes the place of the usual front extension of the frames, and to which the front bumper is also bolted.

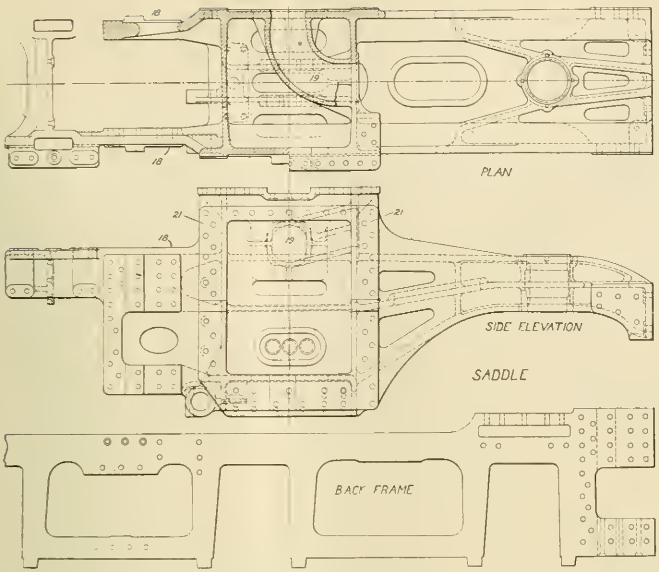
This extension also contains a hole 11 in. in diameter to receive the center pin of the leading truck. In the body of the saddle there is a passage 19 leading from the



Superheater and Smoke Box

center of the left hand side of the saddle, in and to the center of the front near the top, through which the exhaust passes from the low pressure cylinder to the exhaust pipe 20, leading from the saddle to the bottom of the smokebox beneath the nozzle pipe.

In this one casting, then, there is combined the saddle, and an extension to the rear for the attachment of the rear frames; faces 21 for fastening the cylinders; an



Steel Casting of Saddle and Front Frame and Front Portion of Back Bar Frame

exhaust passage from the low pressure cylinders; a front frame extension to bolt to the front bumper; a bolster for transfering a part of the weight to the front truck and a pivot hole for the center plate of the latter.

The smokebox, however, does not rest in the usual manner directly on the main saddle casting. The latter is flat across the top, and between it and the smokebox there is interposed another casting, having the usual curved seat for the reception of the smokebox and to which the latter is rivetted. This casting is, in turn bolted to the top face of the main saddle casting. It is a mere shell, as indicated by the plan view, and may be attached permanently to the smokebox as there is little danger of its being damaged.

This arrangement will greatly facilitate the making of repairs at the front end. If the front extension is bent or damaged in any way, the main saddle casting can be detached without the necessity of cutting the smokebox loose. And, again, the whole boiler can be readily removed from the frames and saddle.

The cylinders are cast separately and bolted to the sides of the saddle in the ordinary manner, except that it is unnecessary to make any provision for the front extension of the frames.

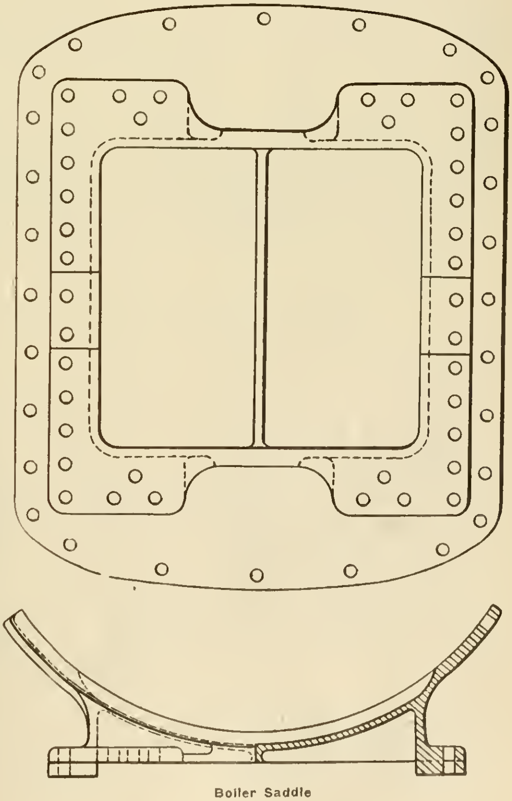
The high pressure cylinder has a diameter of 23½ in. inside the bushing and an overall length of 42 in. The center of the steam chest is 34 in. above the center of the cylinder. As will be seen from the side elevation of the locomotive, the steam pipe comes down on the outside of the boiler and connects, by means of a ball ground joint with the flanged opening 23, which is located over the center of the steam chest. The entering passage has a diameter of 7½ in. The steam follows the line of arrows over the top of the steam chest and around the rib 24 into the chamber 25 from the bottom of which there is a drip opening 26, all of which is shown in the cross section of the cylinder. When the steam has reached the space 27 over the steam chest it turns aside through the passages 28 on either side of the ribs 29 and flows into the opening 30, which is 8 in. wide, and from it enters the steam chest at its longitudinal center and in front of its vertical center line. This diversion of the steam from a direct line of flow from the steam pipe to the steam chest, throws any final moisture, that may be contained in it, against the inner walls so that it drops down into the chamber 25, and is not carried into the steam chest and cylinder.

There are two openings in this passage, one (31) for the relief valve and the other (32) through which the live steam connection to the intercepting valve is made.

The steam is distributed to the cylinder by an inside admission valve which is driven by the Young valve gear, and so exhausted at the ends of the steam chest. From here it flows out through the passages 33 to the inside wall where the two are connected by the space 34. This space runs along the side of the steam chest to the elbow 35, on the top of which there is a flanged and ground ball joint connecting with the bottom of the intercepting valve casing.

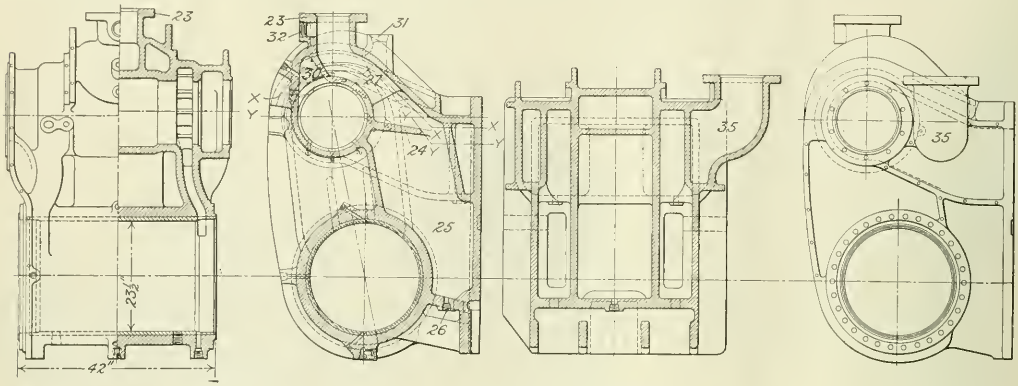
The steam rises up through the intercepting valve and, through another ball joint connection, enters the receiver pipe 36.

This pipe extends up and over the top of the smokebox in front of the



Boiler Saddle

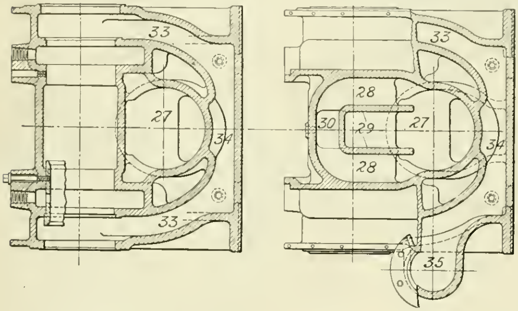
smokestack and down to a connection with the opening to the low pressure cylinder at 37. This leads directly to the center of the steam chest. With an inside



Half Side Elevation Half Longitudinal Section Cross Section Longitudinal Section Through Exhaust Pipe Front Elevation

High Pressure Cylinder

admission valve the exhaust steam flows through the passages 38 outside the space 39 and by way of the passages 40 to the central outlet 41, which is connected to the

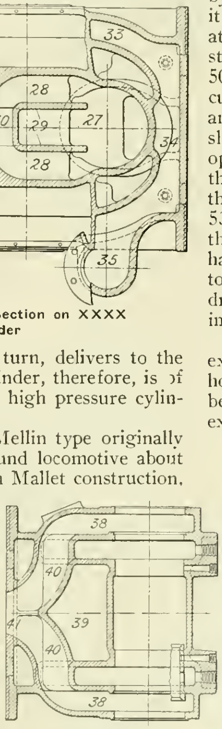


Section on YYYY Section on XXXX

High Pressure Cylinder

passage 19 in the saddle which, in turn, delivers to the exhaust pipe. The low pressure cylinder, therefore, is of the same design as that of ordinary high pressure cylinders having an outside steam pipe.

The intercepting valve is of the Mellin type originally introduced on the Richmond compound locomotive about 30 years ago, and extensively used in Mallet construction, but slightly modified in form to meet the requirements of this locomotive. This valve automatically admits live steam to the low pressure cylinder on starting so that simple action is at first obtained. As soon as the proper pressure has been built up in the receiver space by the high-pressure exhaust, the intercepting valve automatically shifts the cylinders into compound action.



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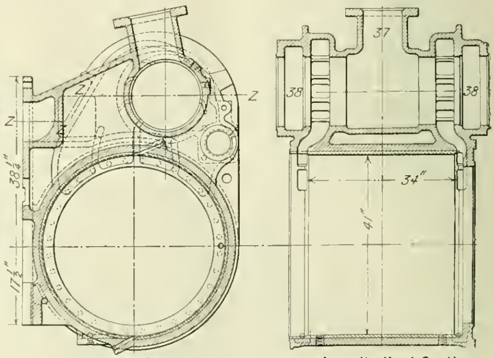
Referring to the engravings of the intercepting valve, whenever the throttle is open live steam enters the casing of the intercepting valve at 43 through the pipe 42 leading from the opening 32 in the cylinder. This steam flows into the passage 44, which surrounds the valve chamber and enters the same through the ports 45. It then enters the cavity 46 in the reducing sleeve 47 of the intercepting valve. This sleeve is loose on the forged stem 48 of the valve and can move longitudinally over it by a limited amount. It also is of two diameters where it moves in the outer casing, and the cavity 46 is located at the junction of these two diameters, so that, as the steam enters, it presses against the two shoulders 49 and 50, which are of different areas; the shoulder 50 being cut in the larger diameter of the sleeve has the larger area and so the greater pressure being exerted against it, the sleeve is moved to the left, uncovering the port 51 that opens into the space 52 leading to the receiver. Steam thus flows into the receiver and builds up a pressure therein and this pressure is then exerted against the end 53 of the sleeve. The area of this end being greater than that of the shoulder 50, when a predetermined pressure has been reached in the receiver, the sleeve is moved back to the right, partially closing the port 51, and, by a wire drawing of the steam, maintaining the desired pressure in the receiver.

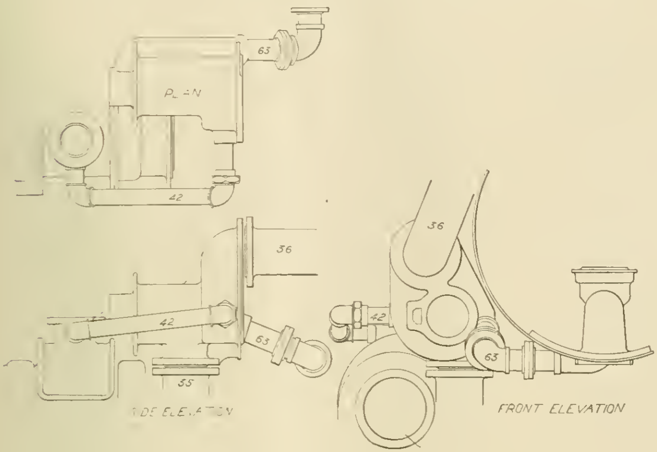
The pressure which is thus built up in the receiver is exerted against the back of the flat-faced valve 54 and holds it against its seat, thus closing the communication between the receiver chamber 52 and the high-pressure exhaust chamber 55.



Cross Section Longitudinal Section

Low Pressure Cylinder

It is evident that if this valve 54 were to be open at the instant of the opening of the throttle valve it would be slammed against its seat with great violence unless some means for cushioning its motion were provided. This is accomplished by means of a dashpot 56 in which a piston, 57, attached to the intercepting valve stem moves. The back of the dashpot is open to the atmosphere through the hole 58 in the cover, and the valve 54 is permitted to come to its seat by the leakage of air from in front of the piston, through the 3/16 in. diameter hole 59. When the engine starts the exhaust from the high pressure cylinder builds up a pressure in the chamber 55 until it overcomes the receiver pressure on the back of the valve 54, and moves it to the right, carry the sleeve with it, and the engine is then in compound operation.



Intercepting Valve and Piping

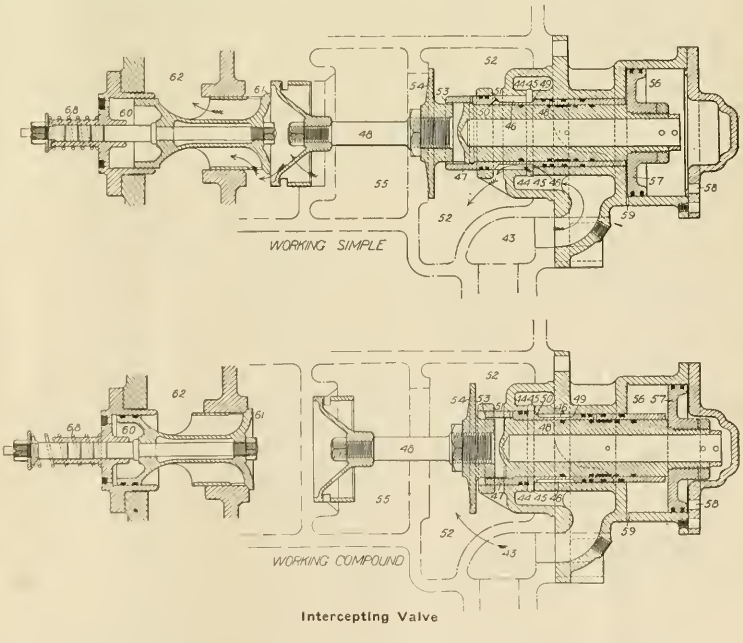
When, however, it is desired to work the locomotive as a simple engine, live steam is admitted to the space 60 at the left of the independent exhaust valve by the engineer, through a special valve and pipe. This space is closed by a piston attached to the valve. As the piston is only slightly less in diameter than the valve 61 itself, a pressure but little in excess of that of the high-pressure exhaust will be sufficient to overcome the pressure on the face of the valve and open it by moving it to the right.

In order that the valve 61 may surely close when the pressure back of the piston 60 is released, it will be closed and held normally in that position by the helical spring 68, located outside of the intercepting valve casing.

Communication is thus established between the high-pressure exhaust chamber 55 and the independent exhaust chamber 62 which is connected by the pipe 63 with the exhaust pipe which it enters and discharges through an annular opening that surrounds the regular nozzle.

The intercepting valve thus not only automatically changes the engine from simple to compound operation under ordinary starting conditions, but permits the engineer to work the locomotive as a simple engine if he so desires.

Such are the principal ones of the many novel features to be found in this locomotive. These may be summed up as the physical combination of the saddle and the front frames; removal of the dry steam and receiver pipes and superheater header from the inside to the outside of the boiler and smokebox; more accessible location of the intercepting valve on the outside of the saddle; application of an interlocking duplex type of low and high pressure outside type of main throttle valve; installation of an automatic centrifugal type of saturated steam separator such as was illustrated in Railway and Locomotive Engineering for September, 1924, in connection with the description of the Mallet locomotive for the Kansas City Southern Ry.; an imperforate fire brick baffle wall for the full length and width of the firebox; a secondary superheater for the steam used by the auxiliaries, and a tender booster of the type illustrated and described in Railway and Locomotive Engineering for July, 1923.



Intercepting Valve

It will be noticed that nearly all of these items make for accessibility and ease of repairing. Indeed the whole design of the engine is such that accessibility for repairs is its predominating characteristic.

The general dimensions of the locomotive are as follows:

Diameter H.P. cylinder........	23½ in.
Diameter L.P. cylinder........	41 in.
Stroke of piston..............	30 in.
Diam. of driving wheels.......	57 in.
Inside diam. of boiler.........	61⅞ in.
Steam pressure	350 lb. per sq. in.
Firebox length	137 in.
Firebox width	75 in.
Tubes, number	145 in.
Tubes, diameter	2 in.
Superheater tubes, number.....	42
Superheater tubes, diam.......	5⅜ in.
Tubes, length	15 ft.
Wheel base, driving..........	18 ft.
Wheel base, engine...........	29 ft.
Wheel base, engine and tender..	65 ft., 7¾ in.
Weight on front truck........	49,500 lbs.
Weight on drivers............	298,500 lbs.
Weight of engine.............	348,000 lbs.
Weight of tender.............	197,800 lbs.
Heating surface, tubes........	1,132 sq. ft.
Heating surface, flues.........	281 sq. ft.
Heating surface, firebox.......	1,124 sq. ft.
Heating surface, arch tubes....	63 sq. ft.
Heating surface, total.........	3,200 sq. ft.
Heating surface, superheater...	579 sq. ft.
Grate area	71.4 sq. ft.
Maximum tractive power Simple at 350 lb. boiler pressure..	84,300 lbs.
Compound at 350 lbs. boiler pressure	70,300 lbs.
Tender booster at 250 lbs. boiler pressure	19,700 lbs.
Factor of adhesion	
Drivers, simple	3.54
Drivers, compound	4.24
Booster	2.72

With respect to the axle load hauling capacity, the records show that in some of its regular runs between Oneonta and Mechanicville, N. Y., it developed dynamometer drawbar pulls as follows:

In simple gear with booster cut in, at starting	105 000 lbs.
In simple gear, at 4 miles per hour......	95,000 lbs.
In compound gear at 5 miles per hour...	75,000 lbs.
In compound gear at 7 miles per hour...	69,000 lbs.
In compound gear at 10 miles per hour..	65,000 lbs.
In compound gear at 18 miles per hour..	53,000 lbs.

Its hill climbing power has also been demonstrated by the negotiation of 15 miles of 1.42 per cent predominating grade line, with fifty cars in compound gear, in 50 minutes. During the last three miles of this pull, on a continuous 1.42 per cent grade, which was run in about eleven minutes, the speed averaged from 16 to 17 miles per hour, the boiler pressure 345 pounds, and the drawbar pull from 46,000 to 48,000 lbs.

It is expected that in a future issue of this paper there will be published details of the steam distribution and performances of this locomotive in service.

Progress in Automatic Train Control

Substantial progress was made during the year 1924 in the work of installing automatic train control devices on the railroads of this country, according to W. J. Harahan, President of the Chesapeake & Ohio Railroad and Chairman of the Train Control Committee, Association of Railway Executives.

Mr. Harahan stated that this work was being done at enormous expense in compliance with the Interstate Commerce Commission's orders, although railroad executives feel that owing to the fact that automatic train stops are not yet a perfected device, the large sums being spent should be utilized in a more direct method of saving lives through accidents such as occur at grade crossings.

Among other things Mr. Harahan said:

The work continues to progress rapidly and every effort is being made to complete it at the earliest practical date, on 8,360 miles of track of the 46 Class I carriers which the Interstate Commerce Commission in its order No. 1 designated for the installation of train control devices and which have not been exempted from that order.

Up to January 1, 1925, train control installations were actually in operation or under construction and under way on 3,592 miles of track or 42 per cent. of the total mileage covered in the Commission's order No. 1.

The total cost of this work when completed in accordance only with order No. 1 of the Commission will be approximately $32,000,000 including a substantial amount for additions to or changes in the existing signal system. This expenditure of millions of dollars is being made in accordance with the order of the Commission by the railroads in the interest of the public welfare despite the general opinion of the carriers that automatic train control is in a development stage and that no practical system has yet been found.

Of the roads named in the original order of the Interstate Commerce Commission, three have completed installations while eight others are from seventy-five to ninety per cent. finished. Nineteen have sections of twenty miles ready for service, some of which are already in operation. In addition, they have also installed the necessary signal equipment and erected pole lines, so that a large portion of the wayside work over the entire divisions designated by the Interstate Commerce Commission has been finished.

The original order of the Interstate Commerce Commission named forty-nine roads, but the St. Paul, Minneapolis & Omaha, the Buffalo, Rochester & Pittsburgh, and the Western Maryland railroads were later exempted. The Commission on January 14, 1924, in its order No. 2 also ordered 47 of the roads listed originally to install train control on a second division and also ordered 45 additional roads to equip one division prior to February 1, 1926.

Subsequently, at the request of the carriers, the Commission suspended the second order so far as the 45 additional roads were concerned.

While the roads are going ahead with the compliance of the Commission's order, they feel that, in view of the fact that train control is now in a development stage, such widespread installation at this time at an enormous cost is not justified and that the results attained will not warrant this expenditure.

While it is claimed that train control will result in an enormous saving of lives, Interstate Commerce Commission reports show that only 134 persons or 6 per cent. of the total fatalities on the railroads in 1923 resulted from collisions both on the right of way and in the yards. Of that number, only twelve were passengers. Compared with this, 2,135 persons were killed in grade crossing accidents during that year.

In view of these facts, the carriers feel that the public welfare would derive a greater benefit and safety would be further conserved if, in most cases, the money to be used for train control could be spent for improving signal systems and for the further protection of grade crossings.

New York Railroad Club Annual Dinner

Largest in History—Doctor Friday's Address on "Future of the Railroads"

The annual dinner of the New York Railroad Club, which was held at the Hotel Commodore, New York, on Thursday evening, December 18, was not alone the largest in the history of the club, but is believed to have been the largest men's dinner ever held in New York City. More than 2,900 members and guests attended the dinner. It so taxed the facilities of the hotel that the committee in charge found it necessary to discontinue the sale of tickets twenty-four hours before the dinner.

Practically every eastern railroad was represented by its president, vice-president, or other executive officials, some of the roads having arranged for their representatives to be seated in individual delegations.

The guests of honor at the speakers' table included three members of the United States Railroad Labor Board, as well as transportation and industrial executives prominent in public affairs.

W. F. Jones, General Storekeeper of the New York Central, West Albany, N. Y., the newly elected president of the club, presided and acted as toastmaster.

The retiring president, F. T. Dickerson, Secretary and Treasurer of the Central Railroad of New Jersey, was presented with a silver tea service and tray.

Dr. David Friday, Professor of Economics of the New School of Social Research, was the principal speaker, his subject being "What the Future Holds for the Railroads." Robert A. Burlen, playwright of Boston, gave a humorous talk on "Uncommon Sense." The addresses were broadcasted by Station WEAF, through the courtesy of the American Telephone and Telegraph Company.

Keen interest was attached to Dr. Friday's remarks because of the prominent place he has held for many years in economic and agricultural circles. A former president of the Michigan State Agricultural College and professor of economics at the Universtiy of Michigan he has been widely sought as a consulting economist. During the war he served as an expert on taxation in the United States Treasury Department. More recently he has been called upon several times by the railroads for testimony in rate cases before various commissions.

In his address Dr. Friday said that the revival of agriculture assures the railroads a new high mark in traffic for the year 1925 which should result in full employment, good wages, and adequate profits. An abstract of Dr. Friday's address follows:

What the Future Holds for the Railroads

By Dr. David Friday

Professor of Economics of the New School of Social Research

"The industries of the United States are at a turn of affairs such as comes only once in a decade or two. We have just seen an industrial depression, brought to its close by a dramatic revival in agricultural purchasing power. This revival is real and thoroughgoing, and it will have the same consequences this time that came with agricultural revival after the depression of the seventies and again after that of the nineties.

"Business depression is never fully over until agricultural prices have revived, and until the purchasing power of the thirty million people on farms has been restored. But when that does happen, business faces a procession of years during which the demand for goods is large, production is high, and business is prosperous. You may have a temporary business revival, such as occurred in this country in 1922 and 1923, without an agricultural revival, but in the long run it is the latter which brings abiding prosperity.

"This is the fundamental fact in forecasting what the future holds for the railroads. Business prosperity, of course, produces better profits, prices which tend upward rather than downward, and substantial wage payments. But the fundamental fact underneath, the essence of prosperity, is a large volume of production. When production is large, railroad traffic is large; and when traffic is large there is employment for railway labor and profit for the railroad investor.

"The depression of 1893-1896 was brought to an end by the rise in wheat prices during the election year 1896, and by a continuation of that rise in the next year. Production then increased at an amazing rate. Within four years after 1897, the traffic of the railroads had increased 50 per cent. In ten years it had doubled.

"Whenever the production of goods is large, railroad traffic is correspondingly increased. This must follow as the night the day, for in modern industry there can be no increase in production without increased transportation. Both the raw materials and the finished product must be carried by the railroads. What the period of business revival which confronts us means for the railroads, then, is a growth of tonnage and of business. The year 1925 should see a new high-water mark in American railway traffic.

"Such an increase in traffic will inevitably bring with it an increase in gross earnings. It will bring with it also an increase in expenses, and some increase in investment. It takes equipment to carry traffic; and the large expenditures which the railroads of the country have made during the last few years in the face of criticism and discouragement will come to fruition during the next year. The wisdom of the managers in their optimism will be vindicated. They will no doubt continue to buy large quantities of equipment and to spend large sums on improvement. The railroads have always been ready to make improvements when there was any money available for that purpose.

Here is an interesting fact in this connection. In the past the railroads have been able to handle increasing traffic without a corresponding increase in investment. In other words, they have utilized their investment more intensively as traffic has grown.

"Twenty-five years ago their investment was ten billion dollars, and the number of tons of freight originating in the United States was half a billion. The investment per ton of freight originating, was therefore about $20. Since that time the railroads have invested another ten billion dollars. All of this investment was made at rising prices, yet in 1923 the investment account of the American railroads stood at only $15 per ton of freight originating. No other industry in the country has made any such showing.

"The important cost in operating the railroads is not the return upon the investment, but operating expenses, consisting of wages, taxes, and materials. Even in a year like 1923, when railroad profits were better than usual, these operating expenses absorbed more than five times as much as did the return on investment. Unless operating expenses can be held in check, the increased revenues will avail nothing.

"In the past the railroads have been able to meet the rising level of wages, taxes, and prices of materials by greater efficiency and economy in operation. The prices of materials in 1919 were more than twice as high as they were at the beginning of this century. Wages per man employed were two and three-fourths times as high; and taxes per dollar invested were four times as high.

"Yet with all these increases the present cost of carrying a ton of freight one mile is only one-half larger than it was.

"Someone should write an article on the question as to which is the country's most efficient industry. Investigation will disclose that the railroads rank among the highest. If this is continued, the railroads can continue to pay the high scale of wages which now exists in the industry. Moreover, for once in their history, they can approach the point where they are making a return comparable to that which other industries are earning. But the railroads' profit per ton mile of freight is less than it was in 1913, and only three-fourths of what it was at the beginning of this century. The country needs to have railroad profits brought more into line with the prevailing rate of profits that exist in other of the industries.

"In the field of material costs the prospect is brighter for the next five years than it was for the twenty years culminating with 1920. During that period the costs of all materials were steadily rising. Four years ago materials cost three times as much as at the beginning of the century, and more than twice as much as before the world's war.

"For the future it is my opinion that we face no such increase in material costs. During the year 1925 they will rise somewhat, but that rise will not be permanent, nor will it be as great as some people fear. With increasing traffic, increasing efficiency, and comparatively steady material costs, the railroad business holds out every prospect of full employment, good wages, and adequate profits. given those things, the railroads should find no trouble in marketing their stocks and bonds. This will provide the capital needed both for the expansion of their facilities and for improvements which will enable them to carry a continuously larger volume of traffic at a low cost of operation."

Lubrication of the Locomotive From the Standpoint of the Locomotive Engineer*

By E. H. Baker, Service Engineer, The Pennzoil Company

With the development of the modern locomotive, the designer and builder has been restricted in height, width and length, and it is not probable that there will be any change in these limited factors during the life of the locomotive, regardless of what form of power is used.

Notwithstanding these limited factors in the past twenty years, the heavy locomotive has increased in weight from 190,000 lbs. to 385,000 lbs., and owing to improved design and the adoption of economizing and efficiency auxiliaries properly applied and operated, there has been a decrease in weight of locomotive per I. H. P. from 187 lbs. to 98½ lbs. and in increase in thermal efficiency from 5.13% to 8.1%. This is a remarkable performance and places the locomotive in the front rank as a power plant. A comparison with the modern electric locomotive shows a weight of 530,000 lbs. and 3200 I. H. P. or a proportion of 165 lbs. per I. H. P., an increase of 67% on weight per H. P. than that of the steam locomotive. As the electric locomotive is not a prime mover, but dependent upon a power house, which is located many miles away, for its energy, it will have to be greatly improved before it can be recognized as a competitor, except in very heavily congested districts; or where electric power may be obtained very cheaply.

In increasing the size of the power, it has been necessary to considerably increase the bearing weight per inch on all journals, but how much difference there is between the frictional resistance of the locomotive of today and those formerly in service, it is hard to determine.

The only available reliable figures on resistance are those made at the University of Illinois some years ago—on a 2-8-0 type 22 cylinder, 209,000 lbs. on drives and using saturated steam. The average indicated friction H. P. was 14%. What proportion of this was due to lubrication friction it is impossible to determine, as there is no method by which we can separate the friction of lubrication from wheel friction at the rail and the friction due to the inertia of the moving parts. In the refinements of design there has certainly been a decrease in the last item. The second item will increase with the number of the wheels, and that leaves the first item, which is not only reducible, but very easily increased.

In the entire absence of lubrication of journals above, without taking into consideration the friction of other parts, we have a weight on the modern 4-8-2 type of 385,000 lbs. applied at the journals by the 3167 square inches of bearing surface in contact with the journals. This force is great enough to prevent the movement of the locomotive and can only be overcome by maintaining a film of lubricant between the bearing parts. This shows that it is the lubricant that not only carries the load, but must also carry away the heat generated in the lubricant due to the friction of its moving atoms.

The old adage of the "Stitch in time saves nine" applies particularly to the engineer when lubricating the engine. The question is not one of saving a few drops of oil, but rather is it one of saving power, for by saving power you save the cost of lubrication many times over.

Efficiency of anything depends upon the results attained in actual practice and success in lubrication is mainly dependent upon the supervision and application of safe practices by the engineer.

Preparation is 99% of a successful trip and in order to illustrate actual service conditions, we will consider the engineer in passenger service on the run between Los Angeles and El Paso. This is the hardest run in the world on account of its length of 813 miles, crossing two mountain ranges and great stretches of desert where sand storms frequently blow and cutting sand that is picked up by the moving engine and works its way into the journal boxes and bearings. In addition to this, the average solid contents for the water on the entire district is 26.26 grains of solids per gallon, which cause considerable boiler trouble and interferes with cylinder lubrication.

There should be a close co-ordination between engineers and shop foreman. The foreman should call the attention

* A paper read before the Pacific Railway Club.

of the engineer to work reported and done, whenever it might cause trouble, such as applying new wheels and axles, brasses, etc. The engineer should not only report the actual work which is needed, but also give information that will prevent reoccurrence of the trouble.

Inspection

Before leaving the Round House, the engineer should thoroughly examine all parts of his engine, closely watching the parts as he oils around. The spring rigging is often neglected, although it only requires a few drops of oil on each bearing part. Check up on the position of equalizers, springs and hanger, as it frequently happens that the weight is not evenly distributed and will cause one or more driving boxes to run hot.

With the long runs and larger engines now in use, it is increasingly necessary to watch the driving boxes to prevent hot and cut journals. All journals are fitted with a grease lubricator which keeps the grease in contact with the journal, if properly maintained. If not properly maintained, trouble is sure to result. The lubricator should be inspected every trip, and if the journal has been running slightly warmer than usual the perforated plate should be cleaned and particular care taken to fit the screen to the journal. Unless this is done, trouble is sure to follow. When the indicator eye is flush with the bottom of the cellar, the cellar should be re-packed. As the temperature of a grease lubricated journal is higher than with oil, it is necessary to keep shoes, wedges, and hubs well oiled. Screens should be cleaned with steam, never use fire, as it warps and takes the life out of the metal. In fitting the perforated plate see that the entire surface is in contact with the journal.

The following instructions issued by a superintendent of motive power if carried out will prevent most of the hot driving boxes.

"Our practice is to first see that perforated plate is steam cleaned then made to fit the journal properly by use of a mandrel; it is then placed in the subcellar. Care should be taken to see that the top edges of the subcellar do not touch the journal. Care should also be taken to see that perforated plate is applied with the perforated end toward the hub of the wheel. This must also be fitted so that the perforated plate does not bear in the fillet next to the hub. The grease cake is then placed in the subcellar and the radius of same should be the same as the perforated plate with 3/16" clearance all around on the sides and ends of subcellar; the grease cake being chamfered off on the bottom side 1" down and 1" over, as shown on sketch, so that when spring tension is put on follower plate, which must be perfectly free in the subcellar, the grease cake will not spread out so that it will bind on the end or sides of subcellar.

When applying the cellar to the journal a layer of new grease ⅛" thick, should be spread over the perforated plate to come between the journal and perforated plate in order to give the journal lubrication as soon as the engine moves."

Flange Oilers

The value of a flange oiler can never be estimated as it has not only greatly reduced the wear of flanges and rails, but also has prevented a great many derailments, as a flanged wheel curves much more readily when flange or rail is oily than when it is dry and sharp from cutting.

Engineers should always start the flange oiler before leaving roundhouse and frequently look to see if it is properly feeding.

Guide Cup Lubrication

On most of the guides are two cups, one of which has an oil hole leading to the center of under side of top guide bar. As the grosshead shoe has a great pressure on top guide bar when engine is working, very little of the oil from this cup is used. The shoe fitting so closely creates a suction and as the end of the shoe passes the opening of the oil hole, the oil is drawn out and then wiped off on the return motion. The other cup which feeds to the other edges of the guide bar does much better. To get good lubrication shoes should have oil cellars on top surface and oil grooves cut diagonally across from one corner of oil cellar to opposite corner of other cellar.

Pins

Many of these engines have a piston thrust of 70 tons or more. This thrust is carried by a pin not to exceed 8 by 9 inches and makes a bearing pressure of over 1900 lbs. per inch when engine is working at its maximum capacity, which is as near 100% of the time as possible.

Owing to the limit of clearance, it is impossible to lengthen the pin and an increased diameter increases the peripherial speed of the pin, thereby increasing the friction and it is necessary that the engineer make up for these limiting factors by taking no chances of the rod cups ever becoming empty when in service. If it is necessary to fill the cups in between terminals, it should be reported on the regular work report, as it is possible that cups have not sufficient capacity and should be enlarged. Once a pin has been badly overheated, it takes a long time to bring it down to a bearing again and will require constant care until it again has a lubricating skin upon the surface.

Drifting

The greatest protection to good cylinder lubrication is the proper handling of the engine when drifting. Superheated steam has a temperature of from 625 to 725 degrees locomotive practice, If throttle is closed when engine is running at high speed and reverse lever left in running position, the gases in the cylinder will follow the piston to the point of cut off and will then expand to the end of the stroke. This will cause a vacuum in the cylinders and when the exhaust port opens the gases from the front end will pass from the smoke box, then the exhaust pipe and passages to the valves and cylinders where they will mix with a portion of the gases of the lubricating oil, which will vaporize on account of the high temperature and when compression takes place at the end of the stroke, the conditions will be similar to an internal combustion engine and combustion will take place.

The correct method is to bring the throttle back to an almost closed position, better to have too much than too little steam, as one stroke of the piston without steam is sufficient to destroy all the lubrication—drop the lever down to about two-thirds of the stroke and steam will follow the piston without force. The ideal amount is just below atmospheric pressure. This will allow the relief valves to open and air will rush in, mixing with the steam and it will cool and expand to a low temperature until it is more like fog than dry steam. It is impossible to burn the lubrication in the presence of steam.

It is impossible to state just how much feed to give the lubricator, ordinarily one drop of oil to each valve and two drops to each cylinder per minute will furnish good lubrication. Swals should not be used on piston rods, as the rod is an exact indication of the condition of cylinder walls and pistons. Let the appearance of the rod be your guide in increasing or decreasing the amount of oil used. Lubricators should be frequently blown out and should always be filled with a pure Pennsylvania Parafine base oil with a very high flash point.

Never put any engine oil on the piston rod when oiling around as the flash point of the engine oil is very much lower than that of the rod, and it will burn and leave a deposit on the rod.

Comparative tests of different cylinder oils have shown a great difference in the frictional load, and proves that quality not quantity is what gets results.

Boiler Waters

Too much emphasis cannot be placed upon the need of keeping the boiler clean as an aid to lubrication. Any water carried over with the steam from the boiler not only destroys the lubrication of cylinders, piston, valve, etc., but will also deposit solids in the S. H. units and steam passages. These solids are like powdered emery or glass when separated from the water and will cut out bushings and rings very quickly when they reach these surfaces of the frictional parts.

The use of the blow off cock when on the road should be frequent in bad water territory to avoid any chance of water becoming so heavily charged with the different salts to cause foaming.

In checking up on the run between Los Angeles and El Paso on the Southern Pacific Railroad, the average tonnage of trains in passenger service was 662 tons, gallons of fuel oil used, 6,808 gallons, gallons of water used was 74,888 gallons. The average solid content being 2626 grains per gallon. There was placed in the boiler 274 lbs. of solids and the alkalinity of the water would be greater than that of the Great Salt Lake if boiler was not cleaned by frequent blowing off.

The physical conditions are the worst in the world from a lubrication standpoint, yet they are running trains on a 100 per cent on time schedule.

The parts of the locomotive requiring the greatest attention are the valves and cylinders and yet if the engineer forms the habit of doing things right he will automatically handle the engine in such a manner as to insure

Feed in Drops Per Minute Test	Fractional Resistance Percentage of H. P.	Drops Per Minute
1. Lubrication destroyed by improper drifting	22	
2.	18	10
3.	16	4
4. Pure Pennsylvania Paraffine Base Oil..........	11	2

perfect lubrication at all times and as the power delivered at the draw bar is the amount developed in the cylinders less the resistance of engine and tender, and although resistance of the locomotive depends to a great extent upon the number of drivers and length of engine, it depends to a still greater extent upon the efficiency of the lubrication, which offers the greatest saving of any device on the locomotive, as it saves power without any additional expense, but reduces cost of lubrication and maintainance.

Lubrication of Locomotives and Cars

By Dennistoun Wood, Engineer of Tests, Southern Pacific Co.

The function of railroads is to move freight and passengers from place to place and to move them quickly and on time. This must be done at the lowest cost consistent with good service. Power is required to move the trains, overcoming grade resistance, wind resistance and frictional resistance. This last is made up of the rolling friction of the wheels, and sliding friction of the journals on cars and locomotives and moving parts of the locomotives. If this sliding friction can be reduced we reduce one of the factors of train resistance and hence cut down cost of power. This reduction of friction is accomplished by the use of the proper lubricating materials. This is one very vital reason why the operating department is interested in lubrication.

If bearings under heavy load are run at any speed lubrication has to be furnished or hot bearings result and if allowed to run hot long enough trouble is experienced. On trains hot car bearings result in burning off the journals if not taken care of. On locomotives a similar condition may be set up and further, we have the chance of having hot crank pins, hot guides, hot eccentrics, etc. These hot bearings must be seen to or they may result in accident and if they have to be taken care of on the road it means lost time to the trains. Furthermore, hot bearings mean damaged and scored parts and the tieing up of equipment for repairs when it should be earning money. These then are further reasons why the operating department is interested in lubrication.

The primary interest in lubricants for rolling stock on the part of the operating man is whether they are materials that will enable him to get the train over the road on time, in safety and without damage to the equipment. If he shows an interest in the physical or chemical make-up of the lubricating materials, it is because he is trying to insure the obtaining of proper materials for the accomplishment of his main objective as already referred to and to do this at a not unreasonable cost.

No explanation need be made as to why train delays are a serious and expensive matter but to the non-railroader I would say that the delayed train is a thorn in the flesh of the operating or traffic man. Passenger trains chronically late are about as bad an advertisement as a railway can have. Delayed mails have to be avoided wherever possible. Late freight trains cause complaint, particularly if they are fruit trains or "time" freights. A delay to one train, no matter what its class, usually means delays to other trains.

A fruitful source of delays is the hot box. It is most disheartening to get reports day after day showing trains delayed because of hot boxes on cars, hot driving boxes or hot crank pins. Such causes of delays in most cases can be prevented if the proper materials are supplied and are properly applied. Of all precautions, lining will slip and we will always have the hot journal with us but the trouble can and should be kept to a minimum.

To keep the journals cool, the first requisite is the securing of lubricating materials of such character that if properly applied good lubrication is obtained. In doing this the matter of cost must be borne in mind, though quality must not be sacrificed for this. Then it is necessary to see that the proper appliances are furnished to apply the lubricants and last but not least it is necessary to see that the materials and appliances are properly used by the men.

Now let us consider briefly the material, appliance and men concerned with the locomotive and car lubrication.

On locomotives we use valve oil for the cylinder and valves, grease for the driving axle journals and crank pins, engine or car oil for the engine truck and trailing axle journals, and tender axle journals and for the valve motion pins, guides, etc. Sometimes an air compressor oil is used for the air brake pumps, sometimes valve oil.

The use of superheated steam is being more and more extended and this has necessitated a special grade of valve oil. Some roads now carry two grades, one for saturated steam locomotives and one for superheated steam. Other roads use the superheated grade of valve oil for both classes of locomotives with good results. The argument for one grade of oil is that with two grades there is a chance of getting the wrong grade on the locomotive, that oil suitable for saturated steam will not give satisfaction with superheated steam while on the other hand superheated steam valve oil can be used satisfactorily with saturated steam. Valve oil for use with superheated steam should have a minimum flashpoint of about 575° F. and a minimum fire point of about 650° F. Its viscosity at 210° F. will lie between 165 and 230 seconds Saybolt Universal.

The old practice was to lubricate the driving journals and crank pins with oil but modern practice calls for grease lubrication. On some roads two kinds of grease are used, one for driving journals, the other for crank pins. Other roads use one grade of grease for both purposes.

It is a nice problem to get a grease that is just right. The grease must not get too soft when hot or it melts away, resulting in excessive use of grease and possibly delay due to lack of grease and resultant hot boxes. On the other hand it must not be so hard that it will carbonize and glaze on the surface, as this means no lubrication and results in hot boxes. What we ask for is a happy medium.

I spoke of using engine oil or car oil on locomotives. Some roads carry these two classes, using engine oil, as its name implys, on the engine, and car oil on car journals. Other roads use one grade of oil for both purposes. Engine oil is supposedly a better grade of oil than car oil. The engine oil or the car oil, as the case may be, is subdivided in general practice into winter grade and summer grade oil. Winter grade oil will have a slightly lower viscosity and flash point than summer grade oil. Average figures for these oils are:

Winter Grade, viscosity 50 to 55 seconds.

Saybolt Universal, flash 300 to 350° F.

Summer Grade, viscosity 65 to 70 seconds.

Saybolt Universal, flash 300 to 400° F.

The cold test is also important, the winter grade should show not over 0° F., while the summer grade may be as high as 35° F. What I have already said regarding car oil for use on locomotives cover this same grade of oil when used on car journals.

On both locomotives and cars a special grade of oil is used for lubricating air brake triple valves. It must be of such nature that these delicately adjusted valves will not gum up and stick. In the air brake cylinders a lubricant must be used that will keep the leather packing soft and assure satisfactory operation.

On roads of sharp curvature it is very customary to lubricate the flanges of some of the locomotive driving wheels. Crude oil may be used for this and there are numerous devices on the market for applying it. This lubrication reduces curve friction and also reduces flange and rail wear.

To get the oil to the valves and cylinders it is customary to use hydrostatic sight feed lubricators but lately the force feed lubricator has been used to some extent, it being found more positive and reliable in its action.

Grease for the driving journals is pressed into proper shaped cakes in a press. These cakes are held against the under side of the journals by spring pressure, the cakes being placed in cellars and having between them and the journals, perforated plates shaped to the journals. The grease is forced through these plates. The grease for the pins is pressed into cylindrical shape and placed in grease cups, having screw down caps.

Oil for the journals on locomotives and car trucks is carried to the journals by waste which is saturated with the oil and rubs against the journal, the waste being carried in boxes that surround the journals. In locomotive and tender truck journal boxes and passenger car boxes it is customary to use a so-called wool waste. This has a large percentage of cotton waste present. The cotton acts as a wick to carry the oil and the wool gives the waste resiliency. On freight cars a straight cotton waste is usually used. Within the last few years several kinds of cotton waste have been brought out having combined with the cotton vegetable fibre, brass springs, etc., which serve the same purpose as the wool, that is, keeps the waste from settling away from the journals.

Now then, if we get oils and greases that lubricate, provided each reach the spot to be lubricated and further if we get proper waste, have properly designed grease cellars, lubricators, etc., that will put the lubricants where they belong, it is evident that the next point to consider is the human element and to prevent man failures. If we have the best oil in the world and it does not reach the journal, a hot box will occur. The supervisor must be constantly on the watch to see that his men are packing journal boxes properly, placing the waste in them correctly, putting grease in pin cups when needed, seeing that grease cellars are free to move, keeping grease clean, etc.

By constant supervision, delays from hot journals can be kept to a minimum.

Sometimes lubricants are purchased on a guarantee basis, the manufacturer guaranteeing a certain minimum mileage per unit quantity of lubricant. Sometimes the lubricants are purchased under specification. It is a matter of opinion which is the best method. Frequently road service tests are made to determine which of several brands of lubricants are best suited for use. If two brands are found equally good then price determines. If lubricants are purchased to specifications the manufacturer is usually anxious to meet the specification and "go it one better," for he knows that a poor showing of his material is a good indication of placing contracts elsewhere, even though he is not responsible for the specification.

You probably wonder why the railroads continue to use the old style journal bearing when the roller or ball bearing is used so generally. Others no doubt know that roller bearings are used to a large extent under cars in Sweden and that several test cars have been so equipped in this country. The reports made on these cars indicate a tremendous decrease in frictional resistance. I think what prevents the more general introduction of the roller bearing is that it appears somewhat complicated, the present bearing is extremely simple and with the class of labor found about car yards it is well to keep things as simple as possible. It is my belief, however, that with increasing loads, larger units of power and higher cost of fuel, which fact will call for resistance reduction wherever possible, changes will come in design of bearings and their lubrication. Eventually we will have car journals with roller bearings and driving boxes will have some form of forced feed lubrication.

After a train is properly lubricated and on the road, it cannot be expected to take care of itself. The crew must be watchful. If they find indication of hot journals they must take immediate steps to stop the trouble. Many a serious delay could have been avoided by proper care on the part of the crew.

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The High-Pressure Compound Locomotive

The high-pressure compound locomotive, the "Horatio Allen," illustrated in considerable detail in another column is deserving of especial attention on the part of locomotive designers and users, not only because of the advance of seventy-five per cent in the steam pressure above average current practice, but because of the many novel features embodied in its design and construction.

As for the steam pressure of 350 lbs. it may almost be dismissed without a second thought, for it will be received with far fewer doubts and misgivings than would the proposal to use a pressure of 200 lbs. have been received forty-five years ago. We have gone through the struggle of securing an oil that will withstand the high temperatures of our present super-heated steam and Mr. Muhlfeld has very wisely decided to let well enough alone in that particular and limit his temperature of superheat to that already in common use.

In the design of the boiler the water tube principle has been used. This is no new attempt as it has been tried many times, usually without much success. But already a boiler of this type seems to have won its spurs on one road if the statements of the mechanical engineer are to be credited and the giving of a repeat order is any evidence of a satisfactory performance. That the boiler or locomotive has sprung full-fledged into a perfectly satisfactory condition, like Minerva from the head of Jove, is exceedingly unlikely. But so many provisions have been made and the design has been so carefully worked out that there is a strong probability that the modifications to be made will be those of detail only.

One of the outstanding features of the machine is the accessibility of those parts which are usually so covered and protected that repairs can only be effected with the greatest difficulty. The drypipe, throttle valve, and superheater heads are all outside the boiler and can be reached without the disturbance of other parts. The yoke from which the steam is drawn supplies every part of the locomotive and every part is on the outside, and so thoroughly protected by suitable lagging that the losses by radiation are reduced to a minimum.

One of the details that cannot fail to attract attention is the combining of the saddle and the forward extension of the frames into one heavy steel casting. The fastening of the saddle or cylinders and half saddles to the frames has always been a troublesome matter and the connections had a vicious tendency to become loose. There has usually been a slab connection between the front and rear portions of the frames, and this has given comparatively little trouble. Mr. Muhlfeld has retained this form of connection; has increased it in depth and rigidity, and made it one between the rear portion of the frame and the saddle, and let that end the matter.

The removal of the frames and the great depth of saddle thus made possible, has provided a corresponding increase in the efficiency of the fastening of the cylinder to the saddle.

In general appearance the locomotive is not yet altogether pleasing to the eye. But this, like a new fashion, is a matter to which we will soon become accustomed, and it is the customary that is usually pleasing to the eye. While we may not have had quite so wide a departure from previous constructions as this locomotive embodies, there are precedents for changes that have not been, at first, altogether pleasing to look upon. There are, for example, the change from the conical stack, of the wood burner, to the diamond stack; from the diamond stack to the straight stack and the extension front, and many others. However, a locomotive is not built to look at but to haul trains and while it is well that it should be of pleasing appearance we can fall back on the old proverb of: "Handsome is as handsome does."

It is rather unusual to find so many novelties embodied in a single new design and Mr. Muhlfeld has certainly had the courage of his convictions. It must be remembered, too, that it was the combination of this courage and conviction that gave the order for the first Mallet locomotive in this country, which other motive power officials regarded as a monstrosity, until it had demonstrated its value: and it is safe to say that the performance of this new design will be watched with the most intense interest everywhere.

Papers and Addresses

In discussing a long and rather dull paper that was read before the New York Railroad Club a number of years ago, Mr. M. N. Forney remarked that while engineers had great respect for and paid close attention to the limit of elasticity of materials, speakers were apt to be unmindful of the fact that audiences, too, had a limit of elasticity or response that should not be exceeded. A few centuries ago a gentleman by the name of Shakespeare remarked that "brevity is the soul of wit," and less than a century ago Josh Billings said that "if a speaker could not strike ile in fifteen minutes he either had a poor auger or was boring in the wrong place." While at last comes the terse instruction as to public speaking of: "Stand up, speak up and shut up."

In making an application of these aphorisms to the papers that are presented to the railroad clubs, length and the use of sentimental platitudes stare one in the face.

It is rarely that a man is asked to deliver a paper or asks for the privilege of delivering one, who has not a distinct message to present and one that is worth listening to. The trouble is that a fifteen minute message is made to fill in forty-five, and, that this may be done, it is padded with a mass of sentimental platitudes that mean nothing and detract mightily from the essence of the discourse. What earthly sense is there in injecting into a cold blooded, scientific or commercial discourse something to the effect that every man is "entitled to life, liberty and the pursuit of happiness?"

Scientific societies have protected themselves against this kind of stuff by the establishment of publication committees that can delete a paper of its padding and by the use of the ten-minute time limit for presentation.

Foreign audiences do not hesitate to hiss performers that displease them, and college students are not always as courteous as they might be in their treatment of a bore. But, somehow, up to the present, the railroad clubs have often been more courteous and tolerant of speakers who are stretching their limit of elasticity up to the breaking point than they have been considerate of themselves.

The question is as to whether it is better to hurt the feelings of an author whose verbosity exceeds his ideas or put a nervous strain upon his audience. Certainly the blue pencil could be used in a number of papers to the advantage of the reputation of the author and the value of the proceedings. Who will be the first to bell the cat?

The Chief Locomotive Inspector's Report

Restrictive legislation is usually the result of flagrant abuses; of the disregard by individuals as individuals or en masse of the rights of other indviduals. It is quite probable that, had the railroad managers of the seventies and early eighties conducted their business with the same impartiality that they do today, the Interstate Commerce Commission would never never have been born. If they had even under partial regulation have paid any attention to their own slogan of "Safety First," it is more than probable that the Bureau of Safety would still be an organization of the future. But instead of consideration and impartiality there were rebates and favoritisms; and instead of safety first, there has been a flagrant disregard of the first elements of carefulness. Hence the restraints and limitations under which transportation is now being conducted.

It is quite true that the many are called upon to suffer for the transgressions of the few, and unless the few can be made to realize their responsibilities, the restrictions are apt to be even more stringent than they are now.

In his report of a year ago the chief locomotive inspector called attention to the abuses and consequent dangers that had arisen because of carelessness in the use of autogenous welding, and stated that he was reluctant to restrict its use because of the retarding effect it might have on its development. But unless users were more careful and used more discretion in its application he would be compelled to ask authority to enforce restrictions that ought to be voluntary.

As it stands now there are limitations to the applicability of autogenous welding, and the manufacturers as well as the users of the apparatus ought to recognize it and be guided accordingly.

The men who rewelded the back boiler head that is illustrated in another column, ought to have known, after the first weld had failed, that welding was an improper method of making the repairs and should have had recourse to something else. It was taking a desperate chance for a paltry saving, and resulted in the death of two innocent men, whose safety depended upon careful and conscientious work being done in the shops.

The failure of the foreman and workmen to appreciate the seriousness of the work that they did, worked not only irreparable injury to their victims but injured the reputation of the methods that they used. There was absolutely no excuse for the repetition of such a piece of work and indictment for criminal carelessness would have been quite proper.

It is to be hoped that before the chief inspector issues his next report the users of autogenous welding will have come to such a realization of their responsibilities to the manufacturers, their fellow employes and the public that the report may be issued without containing the threat of a request for further restrictive regulation.

A Question of Veracity or Searching for A Group of Honest Men

By W. E. SYMONS

It is an accepted principle among honorable men that anyone making accusation against others involving questions of moral turpitude, honorable conduct or honesty in business matters, should either support their charges with convincing proof or in event of failure, to repair the injury with prompt retraction and proper apology, which prompts us to remind our readers of some of the badly misleading and untruthful statements which only a few months ago were being circulated by politicians and office holders of various degrees of standing in the public eye.

This brings us to the point where it seems quite appropriate to inquire as to the painful silence of certain citizens of the U. S., many of them holding high office in its Government and sworn to defend its institutions and people, who were going up and down this land engaged in the most vicious propaganda against the very foundations on which our country rests and the industries responsible for its prosperity.

If some of our solons at Washington who so vehemently denounced the railways, our courts and most of all successful orderly business institutions would turn back a few pages in the house journal however, they will find men of their type were characterized by Daniel Webster as follows:

1. These persons constantly clamor about everything not entrusted to their keeping.
2. They complain of oppression, speculation and pernicious influence of accumulated wealth.
3. They cry out loudly against all banks and corporations and all means by which small capitalists become united in order to produce important and beneficial results.
4. They carry on mad hostility against all established institutions.
5. They would choke the fountains of industry, and dry all streams.
6. In a country of unbounded liberty, they clamor against oppression.
7. In a country of perfect equality they would move heaven and earth against special privilege and monopoly.
8. In a country where property is more evenly divided than anywhere else in the world, they rend the air shouting about agrarian doctrines, and that a poor man has no show.
9. In a country where wages of labor are high beyond parallel, they would teach the laborer that he is but an oppressed slave.

It will be observed in Webster's denunciation of these professional trouble makers on the floor of the U. S. Senate, no mention is made of their having said a word against railways, for the simple reason that there were little or no railways to attack, otherwise it is fair to assume the foregoing nine items would have been principally, if not, wholly directed against railways and allied interests.

Some 400 years before Christ, Diogenes the great Athenian philosopher, we are told, was found with a lantern seeking an honest man, and if this great apostle of truth and veracity were now returned to this part of the earth on a similar mission, we venture the suggestion that if he were equipped with a 10,000 candle power searchlight, he could not in Washington, D. C., or elsewhere, find an office holder or politician with a sufficient high degree of honesty and integrity in public matters to unequivocally retract the numerous false and misleading statements so freely and openly made only a few months ago, although many of these professional troublemakers and their misguided followers are drawing fat salaries through taxation of people and industries they sought to destroy.

It is not long ago that we not only observed regularly in big head lines in the daily press accounts of what were designated as the terrible slaughter of people on our railways. They were loud in their denunciation of what they termed the criminal carelessness of railway managements, and were "just dying" as it were, for an opportunity to stop the murderous slaughter of innocent citizens.

In 1915 when the above propaganda was being strongly featured the number killed on railways was 8,621 and many of these were tresspassers, while those killed by automobiles was 5,928.

The total number killed on the railways in 1923 was only 7,385, although they handled 992,523,000 passengers, and made a total of 38,049,173,000 passenger miles. A large percentage of deaths on railways were trespassers who, if they had used common sense, would not have been injured. There were only 42 passengers killed in train accidents.

In the automobile field, however, the loss of life is appalling. From 4,231 killed in 1914, the mortality list went rapidly up to 14,520 in 1922, the total for nine years being 86,769, while for 1923 we are told the killed was 22,000 and injured 678,000. Yet our great humanitarian solons who almost worked themselves up into a fit of apoplexy over railway situation seem to be perfectly happy and draw their salaries without ever raising a hand to stop this murderous slaughter of some 22,000 and wounding of almost three quarters of a million of citizens, when it is common knowledge that many thousands of wholly irresponsible and incompetent persons are driving cars and thus endangering the lives of themselves and others and that would not be engaged in a railway organization and should not be permitted to drive an automobile.

It seems to make a lot of difference "whose ox is gored" and our lawmakers and politicians seem to be easily moved on patriotic and humanitarian question when corporate interests are involved, but flop to a state of criminal indifference at the appalling loss of life from automobiles, simply because of private or individual ownership, and it would not in all probability prove to be a good vote-getting scheme if our lawmakers should proceed to devise means to stop this murderous slaughter of our citizens.

For those who care to study the splendid record of the railways in handling passengers in comparison with the increasing slaughter by automobiles we give below the reports for 1923, with the suggestion that here is an excellent field for the activities of those who feel disposed to render a real service to mankind.

Passengers carried	992,523,000
Passengers carried one mile...........	38,049,173,000
Passengers killed in train accidents.....	42
Passengers killed in all accidents.......	138
Employes killed on duty	1,563
Total number of employees...........	1,904,807
Trespassers killed	2,442
Not trespassers killed	3,242
Total loss of life on railways...........	7,385
Number passengers carried one mile to *one* killed in a train accident.....	905,932,692
Per cent of killed trespassing (2,442)..	33%
Per cent of killed trespassing automobiles, etc. (5,684)...........	76%

New Records in Efficiency Made

The results of the efforts of the railroads to increase their operating efficiency and accomplish economies is seen in the report of the Southern Pacific Railroad just issued which shows that in the first ten months of this year four new records in efficiency were made. They were as follows:

"1. Train load of 1,759 tons. This is the heaviest in the history of the road and 106 tons or 6.4 per cent better than that of the same period of 1923.

"2. Decrease of 2.4 per cent in locomotives per train. This item standing alone is not impressive, but considering the fact that it was accomplished in spite of the heavier trainloads moved, it is a real testimony to the good effect of using more powerful locomotives. This decrease in locomotives per train raised the average locomotive load 9.1 per cent, as against 6.4 per cent increase in the trainload.

"3. Per cent load to rating of locomotives, which increased 2 points or 2.4 per cent. This shows more effective use was made of improved facilities provided by the company to meet the needs of shippers. The same efficiency in the use of locomotive power was obtained as last year. The records show that we not only did this but secured still heavier trainloads and so increased our percentage of locomotive efficiency.

"4. Increase of half a ton or 2.2 per cent in tons of freight per loaded car. These figures represent average tons per car of all cars handled, including those received from connections."

No Mechanical Division Convention and Exhibits in June, 1925

At a meeting of the Executive Committee of the Railway Supply Manufacturers' Association held in New York, December 11, 1924, it was decided that no exhibit would be held in the year of 1925.

This action was taken following announcement by the Executive Committee of Mechanical Division 5, American Railway Association, which includes what was formerly the American Railway Master Mechanics' and the Master Car Builder's Associations that they would hold no convention, but a strickly business session in Chicago, Ill., during June, 1925. Complying with the wishes of the A. R. A., the following resolution was unanimously adopted by the Executive Committee of the Railway Supply Manufacturers Association:

"Inasmuch as Mechanical Division 5, American Railway Association, has decided to hold a strictly business session at Chicago, Ill., in June 1925, and expressly requested railway supply representatives not to be in attendance, the Executive Committee of your Association has gone on record as indorsing their action, and the Secretary is instructed to so inform member firms."

Track and Tonnage

It has been pretty clearly demonstrated that track conditions have quite as much influence on the stresses imposed upon it by passing vehicles as the conditions of the vehicles themselves. It would seem to follow as a natural corollary to this that track would also have its influence upon the hauling capacity of the locomotive. We have long recognized that if passenger trains are to be run at high speeds, a smooth, well ballasted, well surfaced track with rails in good condition must be provided. But, we have not been so particular in the matter of tracks used exclusively for drag freights. We have laid them with second hand rails, and not been over-particular in the matter of low joints and poorly tamped ballast. We have thought that the weight of the locomotive would insure the same adhesive resistance on the rail regardless of the contour of either one of them. When a moment's thought ought to have convinced us that such conclusions were erroneous. Take, for example the two areas of contact of a worn wheel on a worn rail and a new wheel on a new rail, the probably superior holding power of the latter is apparent at a glance.

Results Obtained on Rough Track Before Relaying

Test No.	Loco. No.	No. of Cars	Actual Gross Weight in Tons	Adj. Tons in Train, Inc. Caboose & Dynamometer Car	Avg. Wt. per Car in Tons	Average Speed in M.P.H.	Average Actual Draw-Bar Pull in Pounds	Average Draw-Bar Pull per ton of Train lbs
1	15 / 19	68	3980	4388	58.5	7.3	82100	20.62
2	6 / 2	48	2922	3210	60.9	7.1	59100	20.23
3	30 / 17	71	4003	4429	56.4	8.0	80500	20.11
4	27 / 11	68	4172	4580	61.4	7.4	85800	20.57
5	4 / 25	63	3537	3915	56.1	6.8	74800	21.15
6	3 / 16	66	3462	3858	52.5	6.2	72250	20.87
7	26 / 16	73	4027	4465	55.1	5.7	85100	21.13
8	31 / 12	62	4247	4619	68.5	6.8	86550	20.38
9	28 / 26	62	4227	4599	68.2	8.3	88200	20.87
10	27 / 14	67	3926	4328	58.6	7.9	79400	20.22
11	29 / 22	72	3934	4366	54.6	8.0	81200	20.64
12	26 / 18	61	4256	4622	69.7	7.4	85400	20.06
13	23 / 1	62	2762	3134	44.5	9.8	57875	20.95
14	30 / 29	74	3938	4382	53.2	10.2	83500	21.20
Averages		65.5	3814	4207	58.4	7.6	78698	20.64

Results Obtained on Smooth Track After Relaying

Test No.	Loco. No.	No. of Cars	Actual Gross Weight in Tons	Adj. Tons in Train, Inc. Caboose & Dynamometer Car	Avg. Wt. Per Car in Tons	Average Speed in M.P.H.	Average Actual Draw-Bar Pull In Pounds	Average Draw-Bar Pull Per Ton of Train in Pounds
15	8 / 16	65	3789	4179	58.3	7.6	76488	20.18
16	18 / 24	81	4483	4969	55.3	6.9	89900	20.05
17	7 / 10	63	3804	4182	60.4	5.1	76310	20.06
18	27 / 9	76	4586	5042	60.3	5.4	88250	19.24
19	3 / 13	68	3838	4246	56.4	5.5	73800	19.23
20	15 / 10	83	4314	4812	52.0	6.9	82900	19.22
21	19 / 24	74	4363	4807	58.9	6.2	87590	20.07
22	5 / 27	63	3518	3896	55.8	7.03	68840	19.57
23	11 / 20	74	4380	4824	59.2	5.3	84300	19.25
24	13 / 27	87	4449	4971	51.1	4.3	87230	19.56
25	19 / 28	74	4590	5034	62.0	5.0	90000	19.60
26	21 / 22	78	4712	5180	60.4	5.3	93300	19.80
27	12 / 16	77	4544	5006	59.0	4.4	89000	19.58
Averages		74	4259	4704	57.6	5.76	83685	19.65

Tabulation of Train Weights and Resistances on Rough and Smooth Track

Between Worn Wheel and Worn Rail — Between New Wheel and New Rail

Full Size Areas of Contact Between Wheels and Rails

However that may be there is evidence at hand to show the wastefulness of using old rails and bad surfacing for a slow freight track.

There was a certain 0.8 per cent. grade up which the locomotives were unable to haul their alloted tonnage and the fact caused much fuming and fussing in operating circles. The track was not very well surfaced and the rails were second hand, but the speed was low, seven or eight miles an hour. It occurred to the engineer in charge that the rail ends at the joints did not afford sufficient bearing surface for the wheels, and that a worn rail head was not the best preventative in the world against slipping. So without saying a word or so much as asking a by-your-leave he relaid this grade with new rails, reballasted it and brought its condition up to a point suitable for a fast passenger track. It was simply a case of a man having the courage of his convictions.

Of course he knew that he would have to justify such unprecedented conduct, and so in self protection, he obtained dynamometer car records of a miscellaneous lot of trains before and after the change had been made. Then, when the change had been made and he was called to account for his extravagance in laying new rails where the old ones were amply sufficient, he produced his records which silenced all criticism, and here they are:

The several tests were run without any preparation on the part of the crews or the trains, which were caught as they came along and the dynamometer car was put in back of the locomotive. The length of the run over which the tests were made was 4.8 miles and the grade was 0.8 per cent. compensated for curves.

No record was kept of the engine operation; that is of steam pressures, coal and water consumption and positions of the throttle and reverse levers. The information sought being merely that of train weights and their corresponding resistances.

On the dynamometer car a record was kept of the train speeds at each tenth of a mile and this with the corresponding drawbar pull has been plotted for two typical runs, Nos. 4 and 26; the first being over the original track and the second over it after the laying of the new rails. It will be noticed that the actual tonnage on the new track was 540 tons and the adjusted tonnage was 600 tons more than on the old track, with a corresponding increase in the total drawbar pull and decrease of speed; while the average drawbar pull per ton of train was .77 lbs. less on the new than on the old track.

The averages show that an average of 445 actual or 497 adjusted tons were pulled up the grade with 4,987 less pounds of drawbar pull, or an average of .99 lbs. less per ton of train.

In short this change in the track made possible a 11.66 per cent increase in actual tonnage with a reduction in drawbar pull of about 6 per cent, which means that the locomotive efficiency was increased nearly 18.8 per cent.

The total result of this is a pretty complete demonstration that a good track is quite as desirable for slow freight as for fast passenger service and that the laying of those new rails and resurfacing was a very good investment.

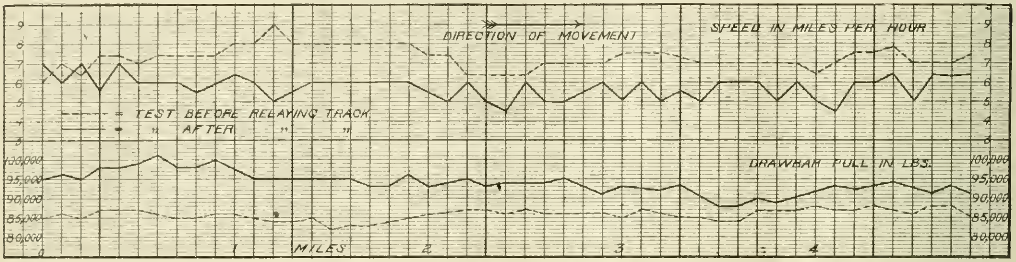


Diagram Showing Typical Speeds and Drawbar Pull Before and After Track Adjustment

The Value of the Requirements of the Safety Laws

In a recent address before the New England Railroad Club, Mr. A. G. Pack, the chief locomotive inspector of the Interstate Commerce Commission, set forth the value that has accrued to the country by the establishment of the Federal inspection regulations.

In discussing the attitude assumed by some railroad officials that the passage of the safety laws was a reflection on their sincerity and desire to do the right thing, he considered this attitude one having no foundation in fact, and justified the enactment of regulatory measures on the ground that a railroad is a steam driven high speed machine, worked to its capacity and at an ever-increasing speed. The Federal safety laws he regards as the safety valves by which this pressure is regulated and prevented from wrecking the machine.

He cited the fact that in the calendar year of 1823 someone was killed every hour and three minutes and asks as to what heights these figures would have soared had it not been for the influence of the government in continually pressing for better conditions?

The Bureau of Safety is charged with the enforcement of the safety appliance laws, and of the hours of service laws and the investigation of accidents.

The Bureau of Locomotive Inspection is charged with the administration of the locomotive inspection law, the purpose of which is to promote the safety of employes and travelers upon the railroads by compelling common carriers to equip and maintain their locomotives in a proper and safe condition to operate in the service to which they are assigned. The Federal requirements of safety appliances on cars and locomotives now practically cover all appliances used by train service employes in making up and operating trains, and Mr. Pack maintained that the establishment of uniformity of such equipment has been of great benefit.

The hours of service law limits the work of train movement employes to sixteen hours, and that, when this has been reached he shall not be required or permitted to go on duty again until he has had at least ten consecutive hours off duty; while an employe who has been on duty to an aggregate of sixteen hours in a 24-hour period must have at least eight consecutive hours off duty.

Train dispatchers, operators and other employes who use the telegraph or telephone for transmitting or receiving orders pertaining to or affecting train movements are limited to a maximum period on duty in any 24-hour period of 9 hours at continuously operated offices and of 13 hours at offices operated during the day time only, except in case of emergency they may be permitted to remain on duty for 4 additional hours, not exceeding 3 days in any week.

In the matter of the investigation of accidents the carriers are required immediately after the occurrence of a collision, derailment, or other accident, resulting in the death of one or more persons, to report the same by telegraph to the commission. If the report indicates that the accident is of sufficient consequences to warrant investigation by the Federal government or if it appears that investigation would develop information looking toward increased safety in operation, an investigation is ordered.

In the Locomotive Inspection Bureau there are one chief and two assistant chief inspectors and fifty inspectors in the field assigned to as many districts. These inspectors are first required to see to it that the carriers make inspections in accordance with the law and then make such repairs as the inspections indicate to be necessary. Then that, if they find defects as the result of their own inspection, they are to notify the carrier that the locomotive must not be used until the defects have been repaired.

The reason given for the extension of the original jurisdiction of the department from the boiler alone to the whole locomotive was that it was found that railroad officials were spending large portions of their appropriations in improving the condition of boilers to the neglect of other parts of the locomotive and tender. Since then the electric locomotive has also been brought under the jurisdiction of the department.

The scope of this work may be realized from the fact that, in the past 20 years, the number of locomotives on the Class I railroads have increased from 46,743 to 65,008, or an increase of 39 per cent, while the total tractive effort of all of the locomotives of the country has increased about 141 per cent. On an average 64,574 locomotives are inspected each year, and of these 60.4 per cent have been found with defects that should have been repaired before they were put in service. Since the law went into effect there have been only nine formal appeals taken from the action of the inspectors. Of these the decision of the inspectors was sustained in five and reversed in four.

There are now authentic records, by which a comparison of boiler accidents can be made prior to the enactment of the boiler inspection law. A comparison can, however, be made between the first fiscal year of the operation of the law, that is for the one ending June 30, 1912, and the fiscal year ending June 30, 1915. During 1912 there were 856 accidents resulting in the death of 91 persons and the injury of 1,005 others. During 1915 this number had been reduced to 424 accidents with 13 killed and 416 injured, or a reduction of 50 per cent, in the number of accidents, 85.7 per cent. in the number killed and 53.5 per cent. in the number injured.

And now, notwithstanding the great increase in the number and power of the locomotives in use and the unsatisfactory conditions existing during the shopmen's strike, the number of boiler accidents for the year ending June 30, 1924, as compared with those for the year 1912, were reduced 54, with 41 per cent. fewer killed and 55 per cent. fewer injured.

One reason why the law has had such a beneficient effect is because it requires all accidents to be investifated and does not confine itself to the more spectacular ones. When accidents are investigated steps are usually taken to prevent recurrence.

It is recommended that owing to the size and complexity of the present locomotive, it should be sent to the shop every thirty days and be thoroughly inspected and repaired so as to be able to run for another thirty days with a minimum of running repairs. If this were to be done, it would greatly reduce the number of engine failures and train delays and make a corresponding saving in the cost of operation.

Another point is the manner in which appropriations are made for repairs. This is usually made on a monthly basis instead of on an annual one. If the latter course were to be pursued it would be possible to distribute it evenly throughout the year, and thus spend it to better advantage. It would insure steady employment and a better maintenance of the shop organization, and add to the economy of repair work.

Some Inside History of a Fast Run

By W. E. SYMONS

The railway and other contemporary press have recently published articles dealing with the high speed runs of railway trains in which is prominent the record of 120 miles per hour made on the Plant System in March of 1901. For the benefit of those of our readers who may be interested in such records we publish the following review of some of the more important speed records, together with some facts and incidents in connection with the run made on the Plant System by one who had much to do with the event.

A speed limit of 12 miles per hour was incorporated in the first English railway charter, but during what was known as the battle of the gauges on the part of the advocates of the broad and narrow gauge track, the Great Western of England made a run from London to Slough of 18 miles in 15 minutes. This was in 1842 and some years later a run was made on this line from London to Didcot, a distance of 53 miles, in 47 minutes.

For longer distances, upward of 400 miles, the fastest time recorded was by the Lake Shore & Michigan Southern between Buffalo and Chicago, in 1905, which was made at the rate of 69.69 miles per hour.

In 1904 it is recorded that a train on the Great Western of England made a run of 118 miles at a sustained speed of 84 miles per hour. The Michigan Central is credited with a run of 225 miles at the rate of 70 miles per hour in 1904, and the Atlantic Coast Line with the same speed on a trip of 172 miles. The Lehigh Valley is reported to have made a run of 44 miles at the rate of 80 miles an hour, and the Burlington with a run of 14 miles at the rate of 98.7 miles an hour in 1902.

On short runs, higher speeds have been recorded for the locomotive No. 999 of the New York Central which made a record run of a mile in 32 seconds, or at the rate of 112½ miles per hour. A number of unusually high speed records were made in 1904, notably on the New York Central at Croton, New York, where a speed of 105 miles was attained; on the Michigan Central a run of 3¾ miles in two minutes; and the Philadelphia & Reading at Egg Harbor, when 5 miles was recorded at the rate of 115 miles.

Absence of details has cast doubt in the minds of some as to some bursts of speed and a resumé of some of the facts and incidents in connection with the record run of 120 miles per hour may be of interest.

Facts Leading Up to Burst of Speed

For several years prior to this speed record the Southern Railway entered Florida over the Seaboard Air Line, whose permanent way or track was not at that time in physical condition favorable to usual passenger train speeds, which resulted in many complaints from patrons and particularly the U. S. Postal Department on account of badly delayed mails.

The Southern Railway therefore arranged to enter Florida over the Plant System of Railways by building to a connection at Hardeeville some 21 miles north of Savannah, Georgia, and running their trains, engines and crews from Columbia, S. C., to Savannah, Ga., at which point Plant System crews and engines took the train to Jacksonville, Fla., 171 miles.

Early in 1901 the Southern Railway secured a contract to handle the mail over the above route, the conditions of which as to time and speed were not only rather exacting, but in the fulfillment of which officers of the Plant System were obviously interested, as it devolved upon them to make good over their lines.

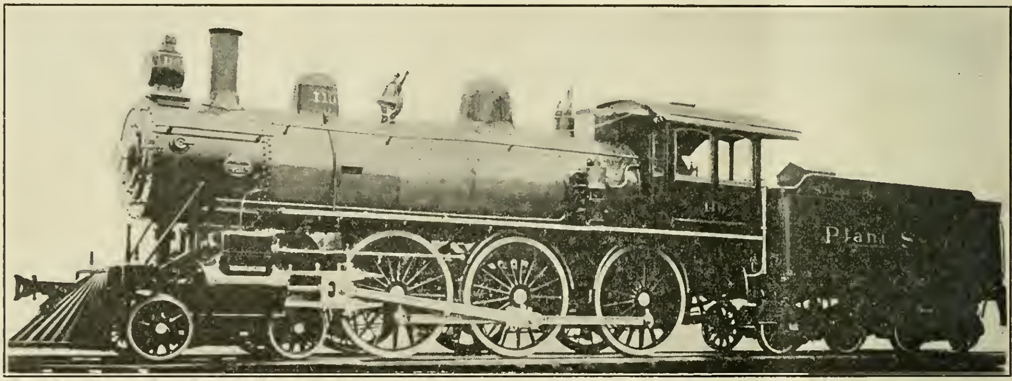
In advance of the movement of first mail train under this contract Plant System officers were fully advised and urged to personally see that everything was in first class condition and that nothing be spared to insure success, as everyone concerned, particularly the U. S. Postal authorities, were not only watching this run carefully, but that some of the latter would most likely be on the train.

In building up the motive power of the Plant System of Railways the writer had in 1900 designed and purchased six fine new fast passenger engines, these engines were designed with a view to future requirments as to increased speed and train load, while certain special engineering features embodied in their design added materially to their capacity and efficiency when operating under sustained load at high speed. Five of these engines were making splendid records in heavy fast passenger service, while the sixth or extra engine was used for such emergencies as might arise.

son tampering with the engine that night, a special watchman was assigned to doubly insure its protection. It was then arranged with the transportation department to run out of Savannah about one hour ahead of this mail train a light freight train with the emergency passenger engine all in good shape, this light freight to take siding some 30 or 40 miles out, then after the fast mail passed it could trail behind all ready to come to our rescue in case anything happened to our engine.

The foregoing plans all arranged we felt pretty sure of our ground and were on hand when the Southern Railway gave us the first mail train, which had been considerably delayed on their own line.

We coupled on, tested the air, compared watches, read orders, etc. Mr. Gannon anxiously inquired if some of the lost time could be made up, and if the run could be made in 3½ hours. The writer answered that the train could be put in Jacksonville in less than 3½ hours, and that if the engine hung together, and the track supported it, it would be made in less than 3 hours, and that I was going to ride in the cab to see that it was done. So with



Locomotive No. 110 is an Exact Duplicate and Sister Engine to No. 111 Which Made Notable Speed Record

With the foregoing as a background or setting, official notice was received in March, 1901, that the Southern Railway would deliver to us the first mail train under this contract.

In addition to the regular official circularized notices to all concerned, Mr. Frank S. Gannon, Vice-President of the Southern Railway dropped the writer a personal note expressing the hope that I would be sure to have one of the best of our new high steppers on this train and thus not only meet the conditions to which he had subscribed but add new laurels to our own well established reputation for successful handling fast passenger trains.

The schedule time of our fast passenger trains between Savannah and Jacksonville, 171 miles with 8 and 9 cars, weight about 350 to 380 tons, was 4 hours and 20 minutes to 4½ hours, deducting time of 3 full stops, made the actual running time more than 50 miles per hour.

The transportation officers advised me this mail train would consist of three cars (weight about 140 tons) and asked if I felt safe in pledging its movement over our lines in 3½ hours, to which I replied that if the track (superstructure) stood up and held the engine, I would consider it an easy job to make the run in less than 3 hours, and to this figure I stood committed.

The best passenger engine and crew were assigned to the run, the engine was put in first class condition the day previous and to guard against some mischievous per-

this declaration of purpose as to time and speed we pulled out, and were soon clipping off mile posts in 45 to 40 seconds.

As we passed ways station 15 miles out of Savannah I smelled a hot box and almost at the same time the engineer and fireman made the same discovery. We were making about 85 to 90 miles per hour. We stopped at Fleming 23 miles out of Savannah, and to those who came out of the Pullman car it at first blush looked to them as though we had failed before we were well started.

Mr. Gannon threw up both hands in horror and disgust, exclaiming, "we will never hear the last of this," and in this sentiment certain others, who were uninformed as to our emergency preparations, readily joined. When asked if another engine could be secured from Savannah in an hour or so I answered, Gentlemen, there is a duplicate or sister engine now on the siding here within 500 feet of us all ready for the fray, and will be coupled to this train in less than 10 minutes, we will yet make Jacksonville in less than 3 hours. The writer rushed over to the emergency engine, and shouted to the engineer, whose name was Albert Lodge to cut off from his train and get over on the mail train and put it in Jacksonville, a distance of 148 miles in 2 hours and 10 minutes.

The writer was in the engine cab the entire distance and noted the passing of many mile posts in less than 40 seconds, while Mr. Gannon and his party in the Pullman car with stop watches stated that numerous mile posts were passed in 33 to 31 seconds, and that at one point 5 miles were made in 2½ minutes, or at a speed of 120 miles per hour.

The engine at end of run was in first class condition, cool all around. Everyone was happy, particularly Mr. Gannon and his party, and thus was established, purely by accident, this record for speed.

Fast and unusual runs on railways are not always prepared for in advance, such as other forms of testing speed or endurance, although some speed records may result from a more or less definite program.

In this case, if we had on this line prior to this run, claimed leadership in locomotive speed, we would have, in all probability, been laughed at by some and doubted by many. As it was we happened to do something far in excess of what we ourselves or anyone else expected, and as a result were acclaimed.

Terminal Inspection of Locomotives

A Report to the International Railway General Foreman's Association

When engines arrive at Roundhouse from train yards they are first inspected by the engineer, who examines engine very carefully and also confers with his fireman relative to defects which have been noticed enroute so they can be properly reported. After engine has been thoroughly inspected by engine crew work report is made out by the engineer showing defects disclosed by his inspection.

Engine is then turned over to the hostler, who handles it from ash pit, to and from coal sheds, etc. Engine is then placed over inspection pit where roundhouse inspector examines same from pilot to rear of tender. Roundhouse inspections, we find, vary at different terminals. Some of the railroads require the roudhouse inspector to make his inspection on the outside and also require him to put engine on top or bottom quarter, set air and have helper thump engine to locate pounds in rods and wedges. Practically the same procedure is gone through in detection of cylinder steam leaks. After the engine is thoroughly inspected by roundhouse inspector, work report is also made out by him and reaches the roundhouse foreman almost as soon as engine is placed in roundhouse to be worked on.

After engine is placed in roundhouse the boiler inspection is made. The front end, fire arresting appliances, grates, ash pan, firebox, brick arches, etc., are thoroughly inspected and the defects noted are listed on roundhouse inspector's work report. Inspection is also made of the cab cards, washout records, etc., to insure strict compliance with the Federal laws covering locomotive inspection.

Various methods are in effect on the different railroads for maintaining record of locomotives requiring inspection and it is the opinion of this committee that it would be a dfficult matter to advocate any standard practice. Local conditions, based principally on the number of different divisions operating into a terminal, should govern.

After the engineer's inspection report has been filed, also report of inspection made by roundhouse organization, the roundhouse clerk takes each individual work report and makes out the necessary work slips. These work slips are delivered to the foreman in charge of repairs who in turn properly distributes them to the various mechanics assigned to different classes of repair work and he follows up the men to see that the work is properly performed.

In selecting a roundhouse inspector merit and capability should be the dominating factors in making the appointment. The inspector should be strongly impressed with the importance of promptly reporting and recording all defects developed by his inspection on work reports maintained for that purpose and should be governed strictly by the facts and not influenced by a desire to gain "favor" with the foreman by "omitting reporting some of the defects." Then it is up to the roundhouse foreman to see that all the work is properly performed.

Rules and instructions governing the inspection and testing of locomotives, tenders and their appurtenances issued by the Interstate Commerce Commission cover locomotive inspection in its entirety and the inspector who is fully conversant with the rules and requirements and will report his findings accordingly has the making of a better inspector than one who has his own ideas and his own interpretation of the inspection laws.

In the inspection of inbound locomotives there is no particular feature that should be given preference in the inspection. Each and every part of the locomotive mechanism should be closely and thoroughly inspected and any defects disclosed properly reported. Some railroads particularize in special inspections, but it is the consensus of opinion of this committee that the terminal inspector should reign supreme in his findings. If a man appointed as an inspector is fully capable in the judgment of his supervising officers, his authority should not be questioned in the making out of defective work reports. We do not believe or recommend, however, that engineers should be relieved of making work reports when they bring their engines to the inbound track. The engineer should be required to inspect his engine at the completion of the day's work or trip and make out work report covering all defects he has noticed while operating engine that might not be visible to ordinary inspection made by the roundhouse inspector. In addition, at some terminals, locomotives tie up at their completion of the day's work, particularly switch engines, where no roundhouse inspection is made account of engines being held at outside points. Under the provisions of the Interstate Commerce Commission rules it is essential that an inspection be made; therefore, it is the recommendation of this committee that the engineers be required to make out inspection report of their locomotive at all times, irrespective of the roundhouse inspection.

After the engine has been thoroughly inspected on inbound track and all defects reported have been repaired, there is another inspection that is made at most terminals which might be termed an "outbound inspection."

Most roundhouses, in addition to a boiler inspector, also have an engine inspector whose duty is to examine all parts of a locomotive other than the boiler and its appurtenances and to sign the Monthly and annual locomotive inspection reports in conjunction with the boiler inspector. It is also this man's duty to test and inspect engines before going to work after all defects reported have been repaired. This engine inspector gets a differential in rate over the mechanics which is an incentive to him to be more thorough in his work and at the same time impress upon him his responsibilities. It is this inspector's duty to see and know that all work reported has been properly taken care of and that no engines are dispatched that have defects in violation of the Interstate Commerce Commission rules. When an engine is placed on an outbound track for service this inspector after examining engine makes an orifice test if necessary. The air brake equipment is also tested out and if any defects develop they are immediately taken care of. While testing brakes the inspector ascertains correctness of the piston travel, examines various piping to see that there are no air leaks and he is also held responsible for the periodical inspections that are to be made of certain parts of locomotives—as example: cylinder packing to be examined once every sixty days, air pumps to be cleaned and tested every ninety days, etc. All inspections made by him as detailed above are properly recorded in books provided for that purpose. At some terminals this man is referred to as a "Test Out Man." It was thought when first putting this system into effect that account of requiring additional labor it would result in additional expense. But experience has developed that it has actually reduced the labor expense, due principally to the fact that defects were discovered by this inspector which might possibly have caused delay or break down on line of road had they not been detected and repaired.

In addition to the outbound inspection detailed above, the hostler also assists in this inspection. One of the requirements of the hostler before taking an engine from the roundhouse is to examine same very closely, close off air pump drains, main reservoir drains, etc., and other appurtenances, keeping record of his inspection on a form.

To preclude the possibility of finding defects, locomotive inspection in compliance with the federal laws is handled differently at the various terminals and this committee in making a study finds that Southwestern Railway has a system in effect which we think is one of the best insurances against the possibility of the finding of defective power by federal inspectors. The railroad in question employs a general inspector of locomotives. This inspector works under the direct supervision of the superintendent of main shops and is invested, insofar as the railroad company is concerned, with the same power as a federal inspector.

This general inspector visits the various terminals on his railroad and inspects engines only after the regular inspector has completed his work and the engine has been O.K.'d for service. After his inspection has been completed he makes out report of his findings, listing all defects on a small pink form similar to the form five used by the federal inspectors. These special forms are made out by him covering engine inspected regardless of whether or not any defects are found. One copy of form is sent to the superintendent of motive power, one to the shop superintendent, one to the master mechanic and one to the roundhouse foreman. This inspector is invested with the necessary authority to tie up engines, irrespective of whether or not it will cause delay in train movement, until all work he finds has been completed. This general inspector has no other duties than to follow up locomotive inspection, know that all defects are being reported and necessary work performed. He is not subject to any instructions other than those emanating from the superintendent of motive power and shop superintendent and it has been the experience of this railroad that in selecting a man to fill this position he must have the personality and disposition to report all work, regardless of local master mechanic or roundhouse foreman's wishes and regardless of whether or not report made by him be detrimental to either one. This system of inspection also tends to make the local inspectors more careful in their work as they are aware of the fact that if too many items of work are reported on the "Pink Form" they will be called upon to explain why they did not find these defects before engine passed through roundhouse and was reported O.K. for service. This general inspector is assigned to territory which he can cover about once every two weeks and his visits to the various terminals are for three or four days, or for such time as will give him an opportunity to inspect every engine assigned to that particular district. This general inspector makes his inspections at night as well as during the day, therefore, local inspectors do not know when he might call and inspect their engines.

The forms used for locomotive inspection reports on the various railroads differ considerably and it would be a hard matter for this committee to recommend any fixed form of work report; however, the engine inspector's work report should be part of the engineer's inspection work report.

In "Repairs Needed" column should be shown the work required, one item on a line, and space should be provided on report opposite the item of repair to show name of mechanic performing the work. In this manner it is easy to determine who performed each item of work and to definitely place responsibility for any improper repairs. Space should also be provided on work report to show condition of injectors, water glasses, etc., and at the bottom of report should be a caption showing engine inspector's report. Defects found by engine inspector should be entered on this report similar to that reported by engineer. Name of workman making repairs should also be shown on the engine inspector's work report opposite the item of repair as detailed above.

A sample of the work report detailed above is shown below:

Locomotive Inspection Report

Instructions—Each locomotive and tender must be inspected after each trip or day's work and report made on this form whether needing repairs or not. Proper explanation must be made hereon for failure to repair any defects reported and the form approved by foreman before the locomotive is returned to service.

Engine No.....Inspected....Time....M Date........
.... Name of Workman..
Repairs Needed ....
....
....
Condition of Injectors..Gauge Cocks..Water Glass....
Condition of Water Glass Cocks...Water Glass Shield..
Lubricator Shield ....
Condition of Piston Rod & Valve Stem Packing,.Brakes,.
Safety Valve Lifts at ...lbs. Safety Valve Seats...lbs.
Main Reservoir Pressure..lbs. Brake Pipe Pressure..lbs.
Condition of Sanders....Are All Steam Leaks Reported Above?....

(Signed) ....Engineer

Enginemen must carefully inspect their engines after each trip and report their condition on this form whether needing repairs or not. They will be held responsible for defects not reported. No attention will be given to verbal reports or reports not signed by enginemen.

ENGINE INSPECTOR'S WORK REPORT

.... Name of Workman..
Repairs Needed.............. ....
....
The above work has been performed ....Inspector
except as noted on back of this form
and the report is approved...................Foreman
Following repairs were not made to Engine No..........
At...................... Date..............192..
....
....
Approved by................Round House Foreman.
Explanation as to why repairs were not made...........

The committee that rendered this report consisted of E. H. Doherty and J. L. Smith.

The Report of the Chief Inspector of Locomotives

Again Stresses the Importance of Proper Use of Autogenous Welding

A. G. Pack, the chief inspector of locomotives, has issued his thirteenth annual report, in which he discusses conditions as they are at present. He again calls attention to the necessity of careful designing and placing of the water level indicating appliances, and then takes up the subject of autogenous welding upon which he reported a year ago; some of the details of which were reviewed in the issue of Railway & Locomotive Engineering for January, 1924.

Referring to the subject in this report he says:

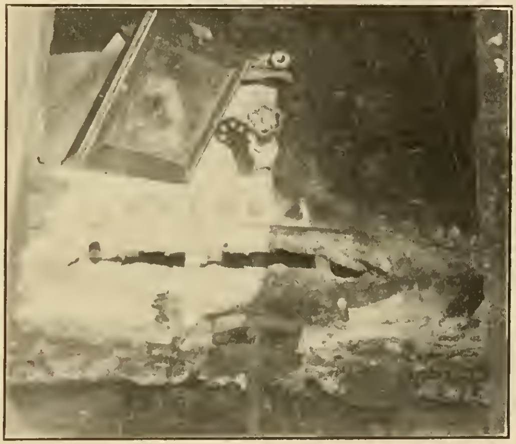
"In view of the number of accidents investigated where welds made by the autogenous process were involved, I feel that particular attention should be called to this subject. Due to the many failures, I have taken the position that this process has not yet reached a stage of development where it can be safely used on any part of the boiler where the strain to which the structure is subjected is not carried by other construction which conforms to the requirements of the law and rules, nor in fire-box crown-sheet seams where overheating and failure are liable to occur, nor on sheets which have been weakened from any cause to the extent of becoming unsafe, nor seams on boiler back head, except where the welded seams are covered with a patch applied with patch bolts, studs, or rivets that will prevent the escape of scalding water and steam in the cab to the extent that might cause serious injury to persons should the welding fail. Attention is directed to the illustration of an autogenously welded seam in the top part of the boiler back head which failed for a distance of 19 inches and opened at the center 1¼ inches, causing the engineer and fireman to be scalded to death and the serious injury of the brakeman. When the failure occurred the throttle was open and the engineer was blown from the cab and the locomotive continued on its journey and collided with twelve coal cars. Investigation disclosed that the crack had existed for about four years and had been welded on three different occasions, the last weld was made about seven months prior to the accident. This and many other similar accidents of which we have records bear conclusive evidence that autogenously welded seams or cracks in the boiler back head are violations of the essential requirements of the law, which provides that it shall be unlawful for any carrier to use or permit to be used on its line any locomotive unless said locomotive, its boiler, tender, and all parts and appurtenances thereof are in proper condition and safe to operate without unnecessary peril to life or limb. Therefore, autogenously welded seams or cracks in the boiler back head will not be accepted by this bureau as being in compliance with the law, except where the seam is covered with a patch held in place by patch bolts, studs, or rivets that will prevent the escape of scalding water and steam in sufficient quantities to cause serious injury to persons.

Necessary action will be taken to impose the penalties prescribed by the law wherever welded seams or cracks are found which are not protected against failure by other proper construction.

So that the conclusion is reached that autogenous welding should not be used on any part of the locomotive or tender subjected to shocks or strains where through failure accident and injury might result.

The most prolific source of casualties due to failure of autogenously welded seams has been in fire-box crown sheets and it has been conclusively demonstrated that the loss of life and limb due to fire-box failures depends very largely upon whether or not the sheets or seams tear.

From a tabulation that has been prepared and which forms a part of the report it appears that approximately 78 per cent of autogenously welded seams involved in fire-box failures have torn, while 15.4 per cent of riveted seams involved have failed. The fatalities where sheets tore have been about eight times as great as where they did not tear. From July 1, 1915, to June 30, 1924, autogenously welded seams were involved in 26.9 per cent of the crown-sheet failures, while 50.7 per cent of the total persons killed in such accidents was where the autogenously welded seams were involved. From the viewpoint of safety, this clearly shows the necessity for constructing fire-box sheet seams in the strongest practical manner, especially so in the so-called "low water zone," or such seams as may be within 15 inches of the highest part of the crown sheet measured vertically. Because the autogenous welding process is in a state of development, and due to my desire to avoid hindering the progress or development of any process of such great value when properly and discreetly used, I have hesitated to ask the commission to establish or approve rules or regulations restricting its use which might retard its development. However, unless the carriers confine its use to parts and appliances where, through failure, accidents and injuries will not result, I will be compelled to recommend more restrictive measures in the near future.



Rupture in Top of Boiler Back Head Knuckle

In the matter of neglect to comply with the law the report contains a list of forty-six railroads against which suits for violations of the law have been brought. These forty-six suits are based on 462 violations or counts of which 302 were for using locomotives while overdue for monthly or annual inspections. In the great majority of cases the railroad pleaded guilty and fines to the total of $30,900 were imposed of which $23,800 were for using locomotives that were overdue for inspection.

Snap Shots—By the Wanderer

It is usually a safe guess that any deeply rooted custom, that enters into our daily life, has some good reason, at the first, for its coming into being; such, for example, as the cut of a swallow-tail coat, buttons at the back and on the sleeves of a coat, the mounting of a horse from the left, the giving of the right arm to a lady, and so on *ad infinitum.*

It is, therefore, always more or less amusing to witness a violent attack on some such custom by one who has made no study of the subject. Such an attack was recently made in one of the big dailies on the custom of Pullman porters of making up the berths in the sleeping cars with the head of the occupant to the front. He demonstrated to his own satisfaction, at least, that this custom was responsible for all of the sleeplessness experienced by night travelers. He showed, beyond all peradventure, that the blood being a moveable fluid surged into the head whenever the brakes were applied and so destroyed the power to sleep; while if the berth occupant were only lying the other way the blood would surge away from the head with the resultant torpor that must inevitably follow. He did not state what the effect of the taking up of slack and the sudden starting of the rear car would have.

This is very interesting, for I had always supposed that insommia on sleeping cars was caused by unaccustomed jar and noise and unusual surroundings. It is strange no one ever thought of it before, for it is a very simple matter to have one's berth made up with the feet to the front. Just tell the porter and he will do it. Once in a while some passenger does have it done, but the only reason I ever heard given for the change was that in case of a collision the passenger preferred to strike the partition with his feet instead of his head.

However, this particular attack was so vigorous that Dr. Crowder, in charge of the department of sanitation of the Pullman Company, was led to tell the reason for the custom, which you and I have always supposed that everyone knew, namely, that by traveling head foremost the sleeper is kept out of draughts and dust deposits. And, by the way, if you wish to see a transformation from the Circassian to the African type, make note of the facial appearance of the eccentric individual who elects, for reasons of safety or somnolence, to ride feet forward of a summer's night with one of his berth windows open.

It is strange that people will go off at half cock in such a manner and that editors will permit them to do so. The result is that the unthinking mob will read such effusions and jump to the conclusion, in this case, that the Pullman Company for some malign and evil reasons of its own, is imposing upon and destroying the comfort of its passengers. Always ready to impute bad motives to a corporation, especially one affiliated with the railroads. Why can't people think a little before they talk and write?

But to change the subject and turning to tools. A cold chisel is usually looked upon as a rough instrument of torture that anybody can make and anybody can use. A mistake! A bad mistake. Among all the tools of the shop the cold chisel ranks way up in the care required in its manufacture. I have found a close coarse grained but carefully made steel to give the best results. I take a naturally coarse grained metal because the continual hammering in use and the redressing will gradually refine and remake the granular structure until it is almost microscopic in its fineness. Of course, in dressing it must never be heated above a cherry color and then the temper should be well drawn down so that the soft metal backs up the edge. Don't think that a multitude of grindings are properties of the best tool and what you want. You have a steel that must stand the racket of pound, pound, pound, hour after hour for days. It must cut into a distorted mass of metal, every blow gives it a wrench and a twist. Every shock that it receives tends to make a new arrangement of the crystals of the metal, and to make it brittle. It never gets the smooth even crowding of the lathe tool, and so its powers of endurance must be correspondingly greater.

Then, after the day's work is done, it is dumped like a piece of scrap into a drawer filled with rubbish and the like.

A well-made cold chisel is a nice tool, and, when properly driven, is capable of turning out work that would surprise those who are unfamiliar with its possibilities. But as you can't make a silk purse out of a sow's ear you can't make a good chisel from poor, cheap steel.

As for the work it can do, that depends upon the artist who holds it and swings the hammer. There was a time when the cold chisel man was a mechanic of the first water and there was nothing that he apparently could not accomplish. Before the days of long planers and big tools the ways of lathes were frequently dressed and finished to truth with a cold chisel and file. Few have seen such beds, but to those who have they remain marvels of high grade mechanical skill. Then there was a time before screw cutting lathes were as common as they are now and long screw threads were cut with a cold chisel and hammer. The method of laying out was simple and efficient. Two strips of square leather of a width equal to the body of the thread or half the pitch were laid side by side on the cylindrical shaft upon which the thread was to be cut. They were wound about it in a spiral or helix and then one was removed leaving the other in place. With a scratch awl the lines of the screw were scribed along the edge of this strip of leather, and when it was removed the artist of the hammer and chisel cut the thread that was thus laid out for him. I wonder how many men there are today in this broad land of ours who would undertake such a job. Some, I presume, among the die sinkers, but they are few and far between in the general run of shops.

However, what is the use of such skill when better and more rapid work can be done on a screw-cutting lathe?

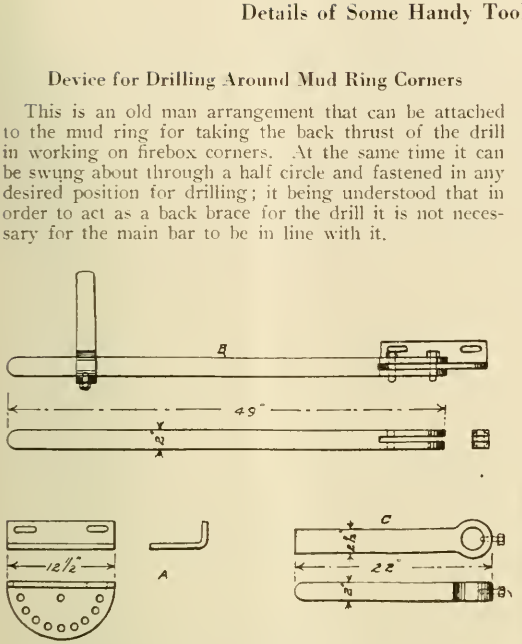
Speaking of that, it is not so very many years since we were able to turn out a fairly accurate screw in this country. I say fairly accurate because I presume that perfect accuracy in screw-cutting is a point yet to be reached by the best of us. But it is certainly not more than fifty years ago that a scale factory in New England wanted an accurate screw cut for one of its graduating machines. A canvass of the shops in the United States failed to find one that would undertake the job. So the order was sent to Old England and, in due time, the precious article arrived. It was embedded in tallow in a hermetically sealed zinc case which was, in turn, housed in wood, and this carefully packed in a second case, so braced that it could be lifted without perceptible deflection. And when it was opened the whole countryside came to view this mechanical marvel. So much for the difference between then and now.

Shop Kinks

Details of Some Handy Tools in Use on Two Railroads

Device for Drilling Around Mud Ring Corners

This is an old man arrangement that can be attached to the mud ring for taking the back thrust of the drill in working on firebox corners. At the same time it can be swung about through a half circle and fastened in any desired position for drilling; it being understood that in order to act as a back brace for the drill it is not necessary for the main bar to be in line with it.



Device for Drilling Around Mud Ring Corners

The base consists of a plate *A* ½ in. thick bent to form an angle and with one of the legs cut into the shape of semi-circle. The short leg has two oblong holes, 2¾ in. by ¾ in., cut in it by which it is bolted to the mud ring or firebox. The semi-circular leg is drilled with a pivot hole at the center and a row of ¾ in. holes in a semi-circle about it, on a radius of 3⅞ in.

The main bar *B* is 2 in. in diameter and 49 in. long over all, and is squared at one end, where it is slotted so as to straddle the angle *A*. It has two ¾ in. holes drilled in it, by which it is held, by means of headed pins, to the angle, in any desired position.

The back stop *C* is rectangular in section and measures 2½ in. by 2 in. and has an eye forged and bored at one end to slip over the main bar. This is held in place by a set screw as shown.

With this arrangement the corner holes in the sheets and mud ring can be drilled without difficulty and with one setting of the old man.

Flue Scarfing Machine

This machine is a powerful belt-driven design of the home-made variety. The bed is formed of two box castings, 1 and 2, which are finished and bolted together as shown, and are carried on the two legs 3,3. The driving shaft with the pulley 4 and pinion 5 is carried by a bracket 9 that is cast integral with the leg at the right.

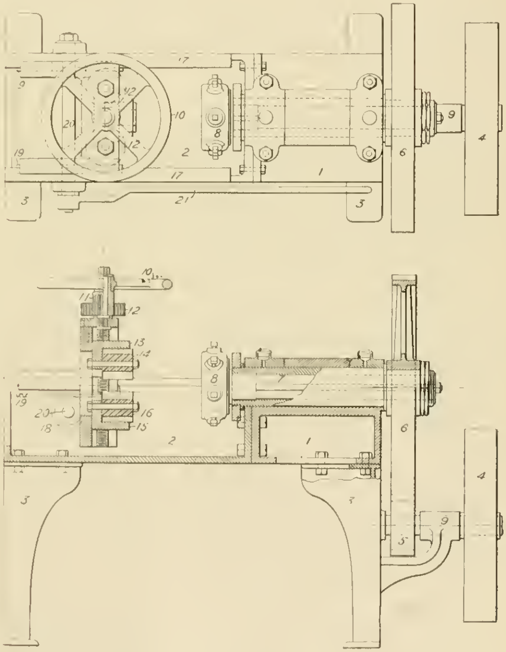
The right hand portion of the bed, 1, has a long bearing cast solidly with it, which is bored to receive the hollow shaft 7, to which the gear wheel 6 is keyed; this gear meshing with and being driven by the pinion 5.

The inner end of the shaft carries the cutter head 8, which is held in place by the bolt 9 which passes through the shaft has its nut bearing against a washer at the outer end.

The vise for holding the tube in place has a bearing at the top and bottom of the tube, both being operated by a single hand wheel. The shaft of this wheel carries a pinion 11 whose teeth have a greater face and which mesh with the two gears 12. The shaft of the hand wheel terminates in a right-hand screw by which the jaw holder 13 of the vise is raised and lowered, carrying the jaw 14, which bolted to it.

The vertical shafts to which the gears 12 are keyed, terminate at their lower ends in screw threads which mesh with the lower jaw holder 15, that carries the lower jaw 16.

As the handwheel is turned the upper jaw is lowered and the lower one raised to grip the tube. The arrangement permits any size of tube to be held and that with its center always in line with the cutter head.



Tube Scarfing Machine

The vise, as a whole slides on the ways 17, and is given the proper traverse by a pinion 18 that meshes with a rack 19 attached to the vise. This pinion is keyed to a shaft 20 to which the lever 21 is also fastened. By means of this lever the pinion is turned and the vise moved to and fro, forcing the end of the tube against the cutters by which the scarfing is done.

A. R. A. to Study Power Brakes and Brake Appliances

The American Railway Association has announced the completion of plans for a complete study and exhaustive investigation of power brakes, and the appliances for operating power brake systems, to be made under the auspices of competent and independent experts.

The investigation, the cost of which will be borne by the American Railway Association, will be conducted by Mr. Harley A. Johnson, Assistant General Manager of the Chicago Rapid Transit Railway. As Director of Research, he will employ such assistants as may be necessary for conducting the work.

The American Railway Association, after conferences with the Director of the Bureaus of Safety of the Interstate Commerce Commission has agreed on the following plan:

1. Steps will be taken to obtain appliances, which it is claimed, meet the views of the Interstate Commerce Commission, as indicated in its preliminary report and conclusions. If the plans or specifications for such appliances are available and the appliances are not yet being manufactured, steps will be taken by the Director of Research to secure such appliances, even to the extent of entering into an agreement to have such appliances made.

2. As soon as such appliances have been obtained they will be given exhaustive tests on the test rack at Purdue University, Lafayette, Indiana, which rack will be completely prepared and brought up to date for the purpose of this investigation.

3. Following the completion of the rack tests such devices will be given road tests, to develop whether or not they meet road conditions safely in service.

4. This program will be carried out with all dispatch and as promptly as the devices for these tests are available.

The investigation will also embrace such further study as may in the judgment of the Director of Research throw further light upon this problem.

Locomotive Building Declines

The Department of Commerce has announced that shipments of new locomotives in the first eleven months last year totaled 1,323. In the first eleven months of 1923 new locomotive shipments totaled 2,860.

Unfilled orders, according to the records of the Department, showed that on December 1 of last year there were 397 locomotives compared with 691 the year before.

The above figures include locomotives manufactured in this country for export to foreign countries. The totals for export, however, are small; 133 locomotives for foreign service were built in the first eleven months of last year, compared with 180 the previous year.

Unfilled orders for foreign locomotives were 35 on December 1 a year ago compared with 66 last year.

Southern Pacific's New Passenger Steamship

The Southern Pacific has added to its present magnificent passenger fleet operating between New York and New Orleans (The Morgan Line), a new modern steamship the "Bienville," which was open for inspection at New York on December 30, and was visited and inspected by a large number of marine engineers, steamship and transportation people and the traveling public. The representative of Railway and Locomotive Engineering was the recipient of the hospitality of the Company as dispensed by the commander of the new ship, Captain Maxon and L. G. Spence, Director of Traffic of the Southern Pacific Company's rail and steamship lines.

The new steamship is appropriately named the "Bienville" after the illustrious Jean Baptiste Lemoine de Bienville, founder of New Orleans in 1718 and Colonial Governor of Louisiana.

The passenger accommodations and public spaces are commodious, well-ventilated and of a design and arrangement not hitherto found in this class of vessel. The interior is so planned as to create an atmosphere resembling that of a fine hotel or palatial home rather than that of a ship.

The "Bienville" is constructed of steel on the Isherwood system with a double bottom and three steel decks together with promenade and boat decks. The ship is protected with seven water-tight buckheads. It was designed and decorated by A. S. Hebble, Superintending Engineer of the Southern Pacific Steamship Lines, was built by the Todd Dry Dock & Construction Corporation at Tacoma, Washington, and launched on July 16, 1924. She left New York for New Orleans January 3, 1925, on her maiden voyage.

Some interesting details of the new steamship are as follows:

Length, 445 feet overall; beam, 57 feet; heighth, 36 feet 6 inches to hurricane deck; displacement, 12,200 tons; loaded draft, 26 feet and a dead weight at that draft of 7,000 tons; cross tonnage, 7,916 tons; net tonnage, 4,842 tons; shaft horsepower, 7,100 at 85 revolutions per minute, single screw; maintained sea speed, 16 knots; capacity, 237 first class and 110 third class; crew, 114 members; fuel, oil; propelling machinery, De Lavel turbines and double helical reduction gears, with six Babcock & Wilcox boilers.

1925 Brussels International and Commercial Fair

The Sixth Official Brussels Commercial Fair, an annual international business exposition, which has become one of the most important Fairs of Europe since the war, will be held from March 25 to April 8, 1925, in the Gardens and Halls of the Cinquantenaire.

As the Fair is organized by the City of Brussels and the Belgian Government, and is under the high patronage of H. M. King Albert, the exhibitors may expect all the guarantees which such an institution offers. The success of the first five Commercial Fairs held at Brussels has increased each year both as regards the importance of the Belgian and foreign exhibits and the amount of business transacted.

The statistics of the fifth Fair, held from April 1 till April 16, 1924, give the following figures: 2,776 exhibitors (916 of these being foreigners from 24 different countries) occupying 31,500 square metres of space.

The charge for space is 800 belgian francs for a stand of 12 square metres. Full particulars about the official regulations of the Fair, insurance, advertising, form of application for space, etc., can be obtained by addressing such request to the Executive Committee, 19 Grand, Place, Brussels, or at the Belgian Consulate in New York City, 25 Madison avenue. While application for space will be received as late as February 15, it will, however, be advisable to give notice of prospective exhibits as early as possible, in order to obtain the best reservations and proper listing in the Official Catalogue of the Fair.

Fewer Deaths at Grade Crossings

The campaign inaugurated on June 1 by the railroads through the American Railway Association to reduce the number of grade crossing accidents has resulted in a considerable saving of lives, according to H. A. Rowe, chairman of the Committee on Prevention of Highway Crossing Accidents of the American Railway Association.

During June and July, the first two months of the campaign, 346 persons were killed and 1,062 injured in grade crossing accidents, compared with 405 killed and 1,043 injured during the same months in 1923. This was an actual saving of 59 lives, although the injury of 19 additional persons for the two months was reported.

In view of the fact that the Department of Agriculture on July 1 showed an increase of 20 per cent in the number of automobiles registered in 1924, compared with 1923, the actual decrease of 59 in the number of lives lost would indicate that the driving public exercised greater care in approaching and passing over railway-highway crossings.

Freight Car Condition

Freight cars in need of repair on December 15 totaled 189,104 or 8.2 per cent. of the number on line, according to reports filed by the carriers with the Car Service Division of the American Railway Association.

This was a decrease of 36 under the number reported on December 1, at which time there were 189,140 or 8.2 per cent.

Freight cars in need of heavy repair on December 15 totaled 145,241 or 6.3 per cent. This was a decrease of 1,045 compared with December 1. Freight cars in need of light repair totaled 43,863 or 1.9 per cent., an increase of 1,009 compared with December 1.

Motive Power Condition

Locomotives in need of repair on December 15 totaled 12,009 or 18.7 per cent. of the number on line, according to reports filed by the carriers with the Car Service Division of the American Railway Association.

This was an increase of 435 locomotives over the number in need of repair on December 1, at which time there were 11,574 or eighteen per cent.

Of the total number, 6,348 or 9.9 per cent. were in need of classified repairs, an increase compared with December 1, of 220, while 5,661 or 8.8 per cent. were in need of running repair, an increase of 215 during the same period.

Classs I railroads on December 15 had 4,080 serviceable locomotives in storage, a decrease of 96 under the number in storage on December 1.

The railroads during the first half of December repaired and turned out of the shops 36,018 locomotives, a decrease of 130 compared with the number repaired during the last half of November.

Effected Date of Tank Car Specifications Extended

In circular No. D. V. 386 the American Railway Association announces that at the request of certain owners of tank cars, and upon recommendation from the committee on tank cars, the effective date of the requirements of section 7 (c) of the specifications for Class I and II tanks cars, and the last paragraph of Section 7 (d) of the specifications for Class III and IV tank cars is hereby further extended to February 15, 1925.

The above sections of the tank car specifications provide that no nipples, valves or other attachments shall project below the bottom outlet cap except while car is being unloaded.

Notes on Domestic Railroads

Locomotives

The Oregon American Lumber Company has ordered one Prairie type locomotive from the Baldwin Locomotive Works.

The Reading Company has ordered 25 heavy type Consolidation freight locomotives and 5 heavy type Consolidation passenger locomotives from the Baldwin Locomotive Works.

The Louisville & Nashville Railroad has placed an order for eight additional Mikado type locomotives with the American Locomotive Company.

The Akron, Canton & Youngstown Railway is inquiring for 2 switching locomotives of the 0-8-0 type.

The Florida East Coast Railway has placed orders for 18 locomotives including 12 Mountain type and 6 switchers with the American Locomotive Company.

The Southern Pacific Company has placed an order for 15 219-ton three cylinder locomotives with the American Locomotive Company.

The Central Railroad of New Jersey has ordered 20 Mikado type locomotives from the Baldwin Locomotive Works.

The New York Central Railroad has purchased 50 locomotive tenders all of 15,000 gal. capacity divided as follows: 35 American Locomotive Company and 15 to the Lima Locomotive Works.

The New England Fuel & Transportation Company has ordered one switching locomotive from the Baldwin Locomotive Works.

The New York Central Railroad is reported to have placed orders with the General Electric Company for 9 electric locomotives for use on its Port Morris branch, also has ordered 10 locomotive tenders of 16,000 gal. capacity from the Lima Locomotive Works.

The Guggenheim Brothers, New York, N. Y., are inquiring for 9 locomotives for export.

The Great Northern Railway has ordered 4 simple Mallet 2-8-8-2 type oil burning locomotives from the Baldwin Locomotive Works. These locomotives will be the largest ever built; the weight of each engine and tender will be 450 tons.

Freight Cars

The Baltimore and Ohio Railroad is inquiring for 1,000 cars and 2,000 car bodies as follows: 1,000 steel gondola cars, 1,000 box car bodies and 1,000 steel flat car bodies.

The Wabash Railway has purchased 200 all-steel hopper cars from the Pressed Steel Car Company.

The Northern Pacific Railway has placed orders covering 800 50-ton gondola cars with the Ryan Car Company.

The Mississippi Central Railroad is inquiring for 100 flat cars.

The New York Central has placed an order for the conversion of 200 box cars into flat cars, and 200 box cars into stock cars with the Illinois Car & Mfg. Company.

The Virginia Smelting Company has placed an order for 2 tank cars with the General American Tank Corp.

The Waite-Phillips Company has placed an order for 150 tank cars, to be of 10,000 gal. capacity, with the General American Tank Car Co.

The Baltimore & Ohio Railroad is reported to be inquiring for 200 steel underframes.

The Sinclair Refining Company is inquiring for trucks for 25 tank cars, 800 gal. capacity.

The Chicago, Burlington & Quincy Railroad is now inquiring for 500 gondola cars of 50 tons capacity.

The Missouri Pacific Railroad has placed orders for 2,040 freight cars as follows: 200 50-ton automobile cars; 800 40-ton automobile cars with 10-ft. staggered doors; 1,000 40-ton box cars, and 40 caboose cars from the American Car & Foundry Company, and 1,000 40-ton box cars with the General American Car Co.

The St. Louis Southwestern Railway has placed an order for 1,000 box cars double sheathed of 40-ton capacity from the Mt. Vernon Car & Mfg. Co.

The Chicago, Indianapolis & Louisville Railroad is inquiring for 500 40-ton box cars.

The Union Railroad has placed an order for 500 steel hopper cars with the Greenville Steel Car Co.

The Chicago, Burlington & Quincy Railroad is inquiring for 1,000 automobile cars.

The Detroit, Toledo & Ironton Railroad is inquiring for 475 70-ton gondola cars, and 50 50-ton flat cars.

The Louisville & Nashville Railroad has placed orders for 2,000 gondola cars with the Pressed Steel Car Company.

The Western Pacific Railroad has placed an order for 70 stock cars with the Pacific Car & Foundry Company.

The Florida East Coast Railway is inquiring for 20 caboose cars.

The Northern Pacific Railway is inquiring for 50 box car underframes and 10 caboose car underframes.

The Pocahontas Fuel Company has placed an order for 300 mine cars with the American Car & Foundry Company.

The Wabash Railway has placed an order with the Streator Car Company for 400 gondola car bodies.

The Western Fruit Express has ordered 1,757 steel underframes from the Ryan Car Company.

The St. Louis Southwestern Railway has renewed its inquiry for 1,000 double sheathed box cars of 40 tons capacity.

The American Steel & Wire Company is inquiring for 14 gondola cars of 70 tons capacity.

The United States Food Products Car Line Corp., New York City, has ordered 50 tank cars of 8,000 gal. capacity from the American Car & Foundry Company.

The Chicago, Rock Island & Pacific Railway has placed orders for repairs to 750 refrigerator cars with the Pressed Steel Car Company.

The Guggenheim Brothers, New York City, are inquiring for 140 ore cars of 30 tons capacity, 30 trailing cars and 3 flat cars for export.

Passenger Cars

The Baltimore & Ohio Railroad has placed an order for 5 dining cars with the Pullman Car & Mfg. Corporation.

The Illinois Central Railroad has placed an order for 3 parlor cars with the Pullman Car & Mfg. Corporation.

The Northern Pacific Railway is inquiring for 14 passenger car underframes.

The Missouri Pacific Railroad is inquiring for 2 dining cars and 2 office cars.

The New York Central Railroad is inquiring for 29 suburban motor coaches.

The Florida East Coast Railway has placed orders for 12 coaches and one dining car with the Pullman Car & Mfg. Corporation.

The Delaware, Lackawanna & Western Railroad has placed an order for 30 all steel express cars with the Pressed Steel Car Company.

The Louisville & Nashville Railroad has placed orders for the following cars: 8 baggage mail cars and 4 baggage cars with the Pressed Steel Car Company, and 4 coaches, 2 dining car shells with the American Car & Foundry Company.

The Pennsylvania Railroad has placed orders for 2 combination passenger and baggage gasoline cars and one trailer with the J. G. Brill Company, Philadelphia, Pa.

The Central of Georgia Railway has ordered 6 passenger cars from the Pullman Car & Mfg. Corporation.

The Missouri Pacific Railroad has placed orders for 10 coaches, 5 baggage mail cars and 5 baggage cars with the Pullman Car & Mfg. Corporation.

The Central of Georgia Railway has placed orders for 6 passenger cars, 3 coaches and one baggage-mail car with the Pullman Car & Mfg. Corporation.

The Chicago & Northwestern Railway has placed orders as follows: 24 coaches, 12 baggage cars and 3 baggage-mail cars with the American Car & Foundry Company, and 11 baggage cars with the Pullman Car & Mfg. Corporation.

the Pullman Car & Mfg. Corporation.

The Central Railroad of New Jersey has placed orders as follows: 23 coaches with the Standard Steel Car Company, and 5

The Southern Railway has ordered 7 baggage express cars from passenger-baggage cars and 2 club cars with the Bethlehem Shipbuilding Corporation.

Buildings and Structures

The Atchison, Topeka & Santa Fe Railway has placed a contract covering the erection of a new boiler shop, plate works and machine shop at San Bernardino, Calif., estimated to cost approximately $525,000 with equipment.

The Cleveland, Cincinnati, Chicago & St. Louis Railway is reported to be planning the construction of enginehouses at Bellefontaine and Galion, Ohio.

The Pennsylvania Railroad is planning to rebuild its shops at Olean, New York, which were recently destroyed by fire.

The New York, New Haven & Hartford Railroad has awarded the contract covering the construction of an engine house at Fitchburg, Mass.

The Erie Railroad plans expenditures of $2,500,000 on its Mahoning Division, which will include, it is reported, a large roundhouse and machine shops at Brier Hill, Ohio.

The Canadian National Railways plan the construction of new car and paint shops at St. Catherines, Ont., to be used for general car repair work.

The Pennsylvania Railroad plans to enlarge its car shops at Todd's Cut, Wilmington, Del., and transfer equipment for passenger car repair work to those shops from West Philadelphia.

The Chicago, Rock Island & Pacific Railway has placed a contract for the construction of an addition to its roundhouse at Rock Island, Ill., to cost approximately $40,000.

The roundhouse and toolhouse of the Nashville, Chattanooga & St. Louis Railway at Hollow Rock Junction, Tenn., were damaged by fire to the extent of $20,000. Plans for rebuilding same are being made.

The Virginian Railway plans the construction of an inspection building at Mullins, West Va.

The Southern Railway is preparing plans covering the rebuilding of its paint shop at Knoxville, Tenn., which was recently destroyed by fire.

The Gulf Coast Lines have placed contracts for the construction of a number of shop buildings at De Quincy, La.

The Pennsylvania Railroad has placed a contract covering a new engine house and shops at Toledo, Ohio, to cost approximately $500,000.

The Central Railroad of New Jersey has purchased 20 acres of ground in Bethlehem, Pa., and it is reported will move all its shops and roundhouses now located at Ashley, Pa., to Bethlehem, involving an expenditure of over $1,000,000.

The Gulf, Mobile & Northern Railroad will spend approximately $750,000 for improvements in and around Mobile, Ala.

The Wabash Railway is reported to be planning the construction of additional locomotive repair shops at North Kansas City, Mo., in connection with the new yards which are being constructed at that point.

The Missouri Pacific Railroad plans the construction of a fuel oil station on Ewing Avenue, St. Louis, Mo.

The Pacific Fruit Express Co. new shops at Nampa, Idaho, on which construction bids were recently opened, will consist of the following buildings: Air brake testing shop, welding shop, tin shop, blacksmith shop, car rebuilding shop, sheet metal shop, machine shop, steel incinerator, boiler house, transfer vault, locker room, meter rooms, storehouse, mill, office building, and five or six other miscellaneous buildings.

The Illinois Central Railroad is reported to be planning the construction of a new 48-stall roundhouse and other shop buildings at Harvey, Ill.

The New York, Chicago & St. Louis Railway has placed a general contract covering the construction of a machine shop extension at Lima, Ohio.

The Norfolk & Western Railroad is planning the construction of an extension to its machine shop at Williamson, West Va.

The Gulf, Colorado & Santa Fe Railway is reported to be planning the construction of a new enginehouse at Gainesville, Texas.

The Fruit Growers Express will build a car repair shop at Oakland City, Ga., to cost approximately $450,000.

The Atchison, Topeka & Santa Fe Railway is reported to be contemplating the construction of a roundhouse and machine shop at Gainesville, Texas, also the construction of an engine terminal including an enginehouse and shop buildings at Emporia, Kan.

The Norfolk & Western Railroad has under construction extensions to its machine shops at Roanoke and Portsmouth, Va.

The Colorado & Southern Railway contemplates the construction of a roundhouse at Fort Collins, Colo.

The Nashville, Chattanooga & St. Louis Railway contemplates the construction of a roundhouse at Hollow Rock Junction, Tenn., to replace the building recently destroyed by fire.

The Wabash Railway is reported to have plans for the construction of locomotive and car repair shops and a classification yard at Peru, Ind.

Items of Personal Interest

D. H. Dailey has been appointed assistant to the general manager of the Chicago & Illinois Midland Railway, with headquarters at Taylorville, Ill.

A. R. Sykes, assistant mechanical inspector of the Missouri Pacific Railroad, with headquarters at St. Louis, Mo., has been promoted to master mechanic of the Little Rock division, with headquarters at McGehee, Ark.

Max Fiedlier, superintendent of the Globe division of the Arizona Eastern Railroad, with headquarters at Globe, Ariz., has resigned to become superintendent of the Inspiration Consolidated Copper Company, with headquarters at Miami, Ariz.

W. W. Walker, master mechanic of the Slaton division of the Panhandle & Santa Fe Railway, with headquarters at Slaton, Texas, has been transferred to the Pecos division of the Atchison, Topeka & Santa Fe Railway, with headquarters at Clovis, New Mexico, succeeding **M. H. Haig.**

J. S. Netherwood, mechanical engineer of the Louisiana Lines of the Southern Pacific Company, has been promoted to assistant superintendent of motive power and equipment of the Louisiana Lines, with headquarters at Algiers, La., succeeding **B. M. Brown.**

G. R. Miller has been appointed master mechanic of the Slaton division of the Panhandle & Santa Fe Railway, with headquarters at Slaton, Texas, succeeding **Mr. Walker,** who has been transferred.

O. B. Schoenky, master mechanic for the Southern Pacific Company, with headquarters at Tucson, Ariz., has been promoted to superintendent of motive power, with headquarters at Los Angeles, Calif., succeeding **Patrick Sheedy**, who has retired.

C. W. Dysert has been appointed mechanical engineer of Louisiana Lines of the Southern Pacific Company, with headquarters at Houston, Texas, succeeding **Mr. Netherwood.**

J. J. Brinkworth has been appointed assistant superintendent of the River division of the New York Central Railroad, with headquarters at Weehawken, N. J.

R. H. Bates, formerly acting mechanical engineer in charge of research and development work for the Chicago Great Western Railroad, has been appointed mechanical engineer, with headquarters at Oelwein, Iowa.

G. F. Burke, general foreman for the Southern Pacific Company, with headquarters at Roseville, Calif., has been promoted to master mechanic, with headquarters at Tucson, Ariz., succeeding **Mr. Schoenky.**

Pat Sheedy, superintendent of motive power of the Southern Pacific Company, southern district, with headquarters at Los Angeles, Calif., has retired on pension. Mr. Sheedy was born on March 8, 1848, and entered railway service in 1864 as machinist apprentice for the New York Central Railroad at Rochester, New York. In 1868 Mr. Sheedy was appointed foreman of the machine shops of the Southern Pacific Company, with headquarters at Sacramento, Calif., and from 1885 to 1902 he served as master mechanic of the Southern Pacific Company on the following divisions: Salt Lake, Humboldt, Coast, San Joaquin and Los Angeles. In 1902 Mr. Sheedy was appointed superintendent of motive power, with headquarters at Los Angeles, Calif., which position he held until retired.

A. H. Wright has been appointed superintendent of the River division of the New York Central Railroad, with headquarters at Weehawken, New Jersey.

Supply Trade Notes

F. A. Merrick, now vice-president and general manager of the Canadian Westinghouse Company of Hamilton, Ont., has just been elected vice-president and general manager of the Westinghouse Electric and Manufacturing Company according to an anouncement made by E. M. Herr, president of the latter company.

Mr. Merrick who will have general executive charge of the activities of the Westinghouse Electric Company with offices at East Pittsburgh, assumed his new duties January 1st. Announcement was also made that the headquarters of President E. M. Herr would be removed from East Pittsburgh to the Westinghouse Building, 150 Broadway, New York.

Frank A. Merrick, the new Vice President and General Manager is a native of New Jersey and received his technical education at Lehigh University. Shortly after graduation he was employed by the Steel Motors Company, a subsidiary of the Lorraine Steel Co., where he was responsible for many important electrical inventions and rose to the position of Chief Engineer.

Later he joined the Westinghouse Electric & Mfg. Company, at East Pittsburgh, Pa., where he had charge of the production of street railway motors. After the formation of the Canadian Westinghouse Company, Ltd., in 1903, he was sent there as Superintendent, and later became Manager of Works and finally Vice President and General Manager.

During the Great War, Mr. Merrick had charge of the factory of the New England Westinghouse Company, at Chicopee Falls, Mass., which was engaged in turning out a large order of rifles for the Russian Government. When the United States entered the war, the War Department ordered the Westinghouse Company to supply its requirements in Browning machine guns, and this work was assigned to the New England plant. Rapidity in the production of these guns was a vital factor in the plans of the Allies, and though Mr. Merrick had to reorganize and largely reequip his factory in order to handle this work, he was able to complete 60,000 guns within eleven months after operations were begun. This manufacturing achievement is generally regarded by the industrial world as being without parallel.

After the war Mr. Merrick was located in London for two years as special representative of the Westinghouse Electric International Company. He then returned to Canada to resume his original duties.

President E. M. Herr, is leaving Pittsburgh after having been there since 1899. He has achieved a notable place in industry. Graduating from the Sheffield Scientific School of Yale in 1884 he became a special apprentice of the Chicago, Milwaukee & St. Paul Railway in the motive power department and later was engaged as mechanical draftsman and test engineer, and superintendent of telegraphs and later as a division superintendent of the Burlington Railroad. In 1890 he was appointed master mechanic on the C. M. & St. P. and in 1892 was appointed to the superintendency of the Grant Locomotive Works in Chicago. In 1895 he was in Russia establishing locomotive works there. Then he was made general superintendent of the Gibbs Electric Company of Milwaukee and later superintendent of motive power of the Chicago & Northwestern Railroad. Thence to a similar position on the Northern Pacific. In 1899 he entered the Service of the Westinghouse Company and after various promotions was elected to the presidency in 1911.

T. R. Langan has been appointed manager of the Transportation Division in the New York Office of the Westinghouse Electric & Manufacturing Company to succeed A. J. Manson recently promoted to Manager of the Heavy Traction Division of the Railway Sales Department at East Pittsburgh. Mr. Langan comes to New York from the position of Manager of the Transportation Section in the Buffalo (New York) district where he had made for himself many warm friends among the railway officials and personnel. His headquarters were at Syracuse.

After taking courses at Pratt Institute, Brooklyn, and while taking night courses at Carnegie Institute of Technology, Pittsburgh, Mr. Langan entered the employ of the Westinghouse Company in 1904 as an armature winder's helper and wireman's helper in the service department. His work from 1904 to 1906 was in connection with the earlier installation of multiple unit control equipments on the Brooklyn Elevated and New York Subway. In 1906 he began the special apprenticeship course at the East Pittsburgh Works.

After taking up construction work in the Service Department in 1908, Mr. Langan was later in that same year made Assistant General Foreman of Maintenance on the electric division of the New York, New Haven & Hartford Railroad with headquarters at Stamford, Connecticut. In 1910 he was back again at East Pittsburgh on special service and engineering work in connection with the development of the present line of Westinghouse HL Control and railway apparatus.

It was in 1913 that Mr. Langan first entered the Sales Department and began his selling career at Baltimore. His congenial personality, his desire to be helpful to those with whom he was associated and those with whom he came in contact and his readiness to always give the other fellow credit, won him success and recognition. From Baltimore, he went to Philadelphia, then to Buffalo and later to Syracuse. His present move to New York places him in charge of the largest District Office Transportation Division of the Westinghouse Company.

The Philadelphia Storage Battery Co., Philadelphia, Pa., and its New England distributor, the **Roberts Battery Co.**, have moved their Boston office from its present location to 1 Brighton Avenue, Boston, Mass.

The Worthington Pump & Machinery Corp., Cambridge, Mass., has awarded a contract covering the construction of a foundry 81 by 166 ft.

The **M. V. All-Weather Train Control Co.**, New York City, has changed its name to the **Burrows Train Control Co.**

The American Car & Foundry Co. plans enlarging its pressed steel department at its Milton, Pa., plant, at an estimated cost of $25,000.

A. R. Holden has been appointed resident manager of the Pacific coast territory of the **General Railway Signal Co.**, Rochester, New York, with headquarters at San Francisco, Calif.

J. F. Kroske has been appointed manager of pneumatic tool sales for **Ingersoll Rand Co.**, in the Pittsburgh territory, with headquarters at Pittsburgh, Pa.

D. E. Sawyer has been appointed vice-president of the **Wanner Malleable Castings Co.**, Hammond, Ind., and will specialize in railway sales. Mr. Sawyer was formerly with the Illinois Steel Co. and the Pollak Steel Co.

The Chicago Varnish Co., 2100 Elston Avenue, Chicago, Ill., will operate in the future under the name of **E. I. du Pont de Nemours & Co.**

The Wine Railway Appliance Co., Toledo, Ohio, has placed a contract covering a two-story plant, 97 by 365 ft., at Toledo, Ohio.

The Cleveland Twist Drill Co., Cleveland, Ohio, has placed a contract covering the construction of a four-story plant in that city.

The Union Metal Products Co., Chicago, Ill., manufacturer of freight car roods and corrugated car ends, plans to remodel the old works of the Keith Railway Equipment Co., at Hammond, Ind., on or about January 1st. It will be occupied by the Union Metal Products Co.

W. S. Campbell has been appointed manager of domestic machinery sales in the eastern district for **Joseph T. Ryerson & Co., Inc.**, with headquarters at Jersey City, N. J.

O. M. Bostwick, New York representative of the publicity department of the **General Electric Company** and formerly advertising manager of the **Sprague Electric Works**, has tendered his resignation to take effect January 1, 1925.

A. A. Corey, Jr., president of the **Vanadium Corporation of America**, New York, announces that an arrangement has been made with the **United States Ferro Alloys Corporation** for the merging of that concern with the Vanadium Corporation of America.

The **Millburn Sales Company**, distributors in the Philadelphia territory for the **Alexander Milburn Company**, Baltimore, Md., has taken over the Metropolitan district, New York City, with headquarters at 309 Fifth Avenue. **E. P. Boyer** and **D. Keyser** will be in charge of the office.

The **Middletown Car Co.**, Middletown, Pa., will commence work shortly on rebuilding its forge shop, which was recently badly damaged by fire.

The **Greenville Steel Car Co.**, Greenville, Pa., has been reorganized. **F. L. Fay**, formerly president, has been appointed chairman of the board and **F. D. Foote**, formerly secretary-treasurer, has been appointed president. Preparations are under way to resume operations about the first of the year.

The **Standard Supply & Equipment Co.**, Trenton, N. J., has been organized to act as jobber in railway and contractors supplies, etc. **Frank E. Thomas** is president of the new company.

Johns-Manville, Inc., New York City, will establish a factory in New Orleans, La., having leased the building of the American Cotton Oil Co., at Gretna. The first unit of the new plant will be in operation about April.

The **Linde Air Products Co.**, New York City, has opened a branch office at Salt Lake City, Utah, in charge of **R. L. Strobel**, and another branch office at Seattle, Wash., in charge of **C. E. Rhein.**

The **Franklin Supply Co.**, New York City, has resumed operations at its Baltimore plant at Baltimore, Md., at 70 per cent of capacity.

The **Southwark Foundry & Machinery Co.**, Philadelphia, Pa., has discontinued its Cleveland, Ohio, office and business in that territory will be handled in the future from the Akron, Ohio, office of the company.

Obituary

William C. Brown, formerly president of the New York Central died at his home in Pasadena, Calif., on December 6. Mr. Brown was born in Herkimer County, New York, July 29, 1853. He entered railway service as a sectionman on the Chicago, Milwaukee & St. Paul Railway in 1869 and became a telegraph operator in 1870. In 1872 he was appointed train dispatcher on the Illinois Central Railroad. He was train despatcher on the Chicago, Rock Island & Pacific Railway in 1875. He entered the service of the Chicago, Burlington & Quincy Railroad as a train despatcher in 1876, was promoted to chief train despatcher in 1880, and to train master in 1881. He became assistant division superintendent in 1884 and was promoted to division superintendent in 1887. In 1890 he was promoted to general manager of the Hannibal & St. Joseph and the Kansas City, St. Joseph, and Council Bluffs Railways, now part of the Burlington. He was general manager of the Burlington 1896 to 1901 when he was appointed general manager of the Lake Shore & Michigan Southern. Mr. Brown was elected vice-president of the New York Central and Hudson River, and the Lake Shore & Michigan Southern in 1902 and in 1905 was elected vice-president of other New York Central subsidiaries including the Cleveland, Cincinnati, Chicago & St. Louis and the Michigan Central. He became senior vice-president of the New York Central Lines in 1906 and was elected president in 1909 and served in that position until his retirement from railway service in January of 1914.

E. E. Hart, consulting engineer of the New York, Chicago & St. Louis Railroad with headquarters at Cleveland, Ohio, died on December 4. Mr. Hart was born on September 18, 1861 at Little Valley, New York. He graduated from Cornell University in 1887 and entered railway service in June of that year as a draftsman on the Chicago Burlington & Quincy Railroad. He was subsequently promoted to assistant engineer and division engineer. In 1895 he left railway service to engage in general engineering practice, returning to railway service in July 1899, as division engineer of the Eastern division of the New York Chicago & St. Louis. In November of that year his jurisdiction was extended over the entire system and continued in the position until 1906, when he was promoted to chief engineer. Mr. Hart was then appointed consulting engineer in February 1924 in which position he was serving at the time of his death.

Wilson Sprigg, assistant master mechanic of the Louisville & Nashville Railroad with headquarters at Covington, Ky., died on December 11, at Elizabethtown, Ky.

New Publications

Books, Bulletins, Catalogues, Etc.

Arc Welding and Cutting Manual.—The General Electric Company has recently issued a 127-page volume, well bound in cloth, under the foregoing title. This has been given the designation Y-2007 and was issued "to acquaint the uninformed in a general way with some of the applications of arc welding, and to provide a simple and logical method by which one may acquire a certain familiarity with the manipulation of the electric welding arc and its characteristics."

The volume is profusely illustrated with photographs, diagrams and charts explanatory of the text. It is divided into three parts, the first devoted to general information on arc welding, the second to a training course of operators, and the third giving a number of applications of arc welding. The manual should prove very valuable in practically all industries and trades. It is being distributed at a nominal price.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

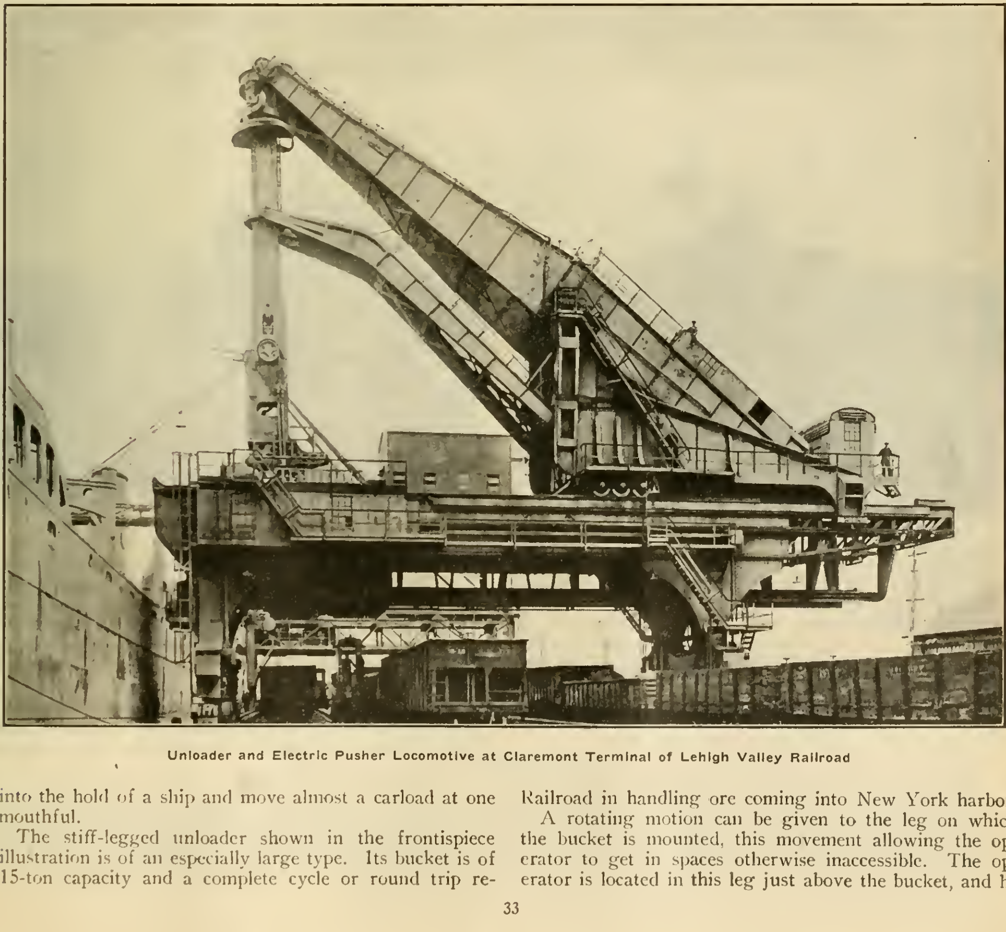
Vol. XXXVIII | 114 Liberty Street, New York, February, 1925 | No. 2

Unloading Ore from Ships to Railroad Cars

Unloader and Electric Pusher Locomotive Operated by the Lehigh Valley Railroad at Claremont Terminal

The use of electricity has resulted in astonishing time savings in unloading and transferring ore from ships to railroad cars. Modern unloaders are in use which reach into the hold of a ship and move almost a carload at one mouthful.

The stiff-legged unloader shown in the frontispiece illustration is of an especially large type. Its bucket is of 15-ton capacity and a complete cycle or round trip requires approximately 55 seconds. The unloader is the property of the Bethlehem Steel Company and is operated by it at the Claremont Terminal of the Lehigh Valley Railroad in handling ore coming into New York harbor.



Unloader and Electric Pusher Locomotive at Claremont Terminal of Lehigh Valley Railroad

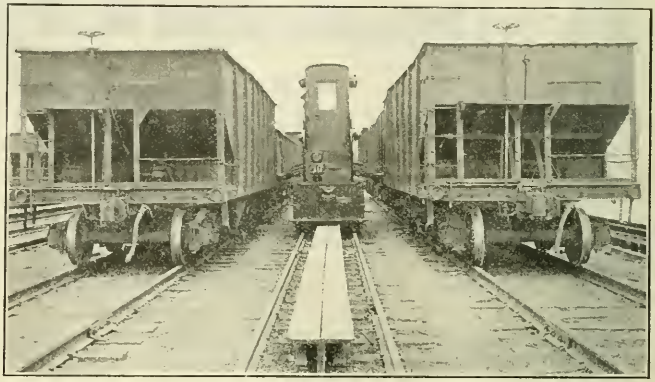
A rotating motion can be given to the leg on which the bucket is mounted, this movement allowing the operator to get in spaces otherwise inaccessible. The operator is located in this leg just above the bucket, and he goes down with it into the ship each time a load is taken.

When the bucket emerges from the hold with a load, the unloader moves back on a track and the load is dumped into a receiving hopper. There the material is weighed and then let down into the cars below, about 50 tons being loaded into each car.

The spottin gof cars is an interesting process, being accomplished with the assistance of an electric pusher type locomotive as shown in the illustration. These locomotives move a string which may total 25 empty cars and move them up into place. After four cars are loaded, they are detached and taken away to be made up in a train. The loaded cars are moved by another locomotive, making the spotter locomotive available at all times for hauling the empty ones, thus eliminating delays.

The unloader is a Hulett type manufactured by the Wellman Seaver Morgan Co. and the motors are of the General Electric MD type. The main hoist motor is a 375 horsepower unit and the bridge trolley and bucket motors are 100 horsepower each.

The speed at which this unloader works is illustrated by the fact that certain boats with a capacity of 21,000 tons can be completely unloaded in 15 to 17 hours and can be completely cleaned out and ready for sailing in 20 to 22 hours. Toward the end of the period, when the bucket cannot get a full load, the time necessary for removal is slightly longer.



Electric Pusher Locomotive in Service on Lehigh Valley Railroad

Head-End View of Car with Aerial Propeller

Side View Aerial Propeller Car Showing Engine

Driving a Railroad Car With an Aerial Propeller

By Geo. L. Fowler

In 1897 when Prof. Samuel P. Langley was pursuing his investigations as to the possibility of flight with a heavier-than-air machine he wished to obtain some information as to what could be done in the way of moving a high resistance body at a slow speed with an air propeller, of a large diameter. Up to that time his investigations had been limited to the use of wheels of small diameters working either on his whirling table within enclosed spaces at the Allegheny observatory and the Smithsonian Institute or on the small models that he had built and flown.

Throughout all of his investigations Prof. Langley had been handicapped by the want of a light high-powered motor and had been limited to the use of a steam engine as the internal combustion engine had not been sufficiently developed at that time to be of any service to him. His engine was, however, a marvel of construction as it weighed only about ten ounces and developed one horse power.

The work that is here described was crude in the extreme and only served to demonstrate possiblities rather than achieve practical results, which was all that he was after.

As the utilization of a steam engine for the purpose would have involved a greater expense than he was prepared to meet, he resorted to the only internal combustion engine that was available.

At that time the founders of what later became the Victor Talking Machine Company were operating a small machine shop in Camden, New Jersey, where they were experimenting both with the development of their talking machine, afterwards the victrola, and an internal combustion engine.

They had built an engine of some horsepower, the amount had not been measured, which had cylinders of about 2 in. diameter and 4 in. stroke. These dimensions are confessedly only approximate. This engine was of the vertical type and was about 3 ft. high and weighed between 300 and 400 lbs.

Operation of the electrified branch of the Pennsylvania R. R., between Burlington and Mt. Holly, New Jersey, had been abandoned, and the privilege of using a portion of the track at the Burlington end was obtained. The internal combustion engine was borrowed and mounted on blocking on an ordinary push car of the section gang, and a two-bladed, propelling wheel 6 ft. in diameter was fitted to the engine shaft. This wheel had canvas surfaces stretched over a light wooden frame work, and the engine drove it at about 500 revolutions per minute.

The car with its load weighed about 1200 lbs. and was run upon a track near the Burlington station where there was an ascending grade of about 2 per cent.

When the engine was started and the propelling wheel brought up to speed, it failed to start the car; but when the car had been given a start by hand the wheel could keep it in motion up that grade and against a stiff breeze at a speed of about two and a half miles an hour. This was increased somewhat on a level, but did not exceed three and a half miles an hour at any time.

As there was no means provided on the engine for recording the thrust, a dynamometer was attached to the car when the engine was stopped and the car towed by it at a speed about equal to that at which it had been driven by the propeller wheel. My recollection is that it took a pull of about 150 lbs. to accomplish this result.

The data obtained was very meagre, but it was sufficient to satisfy Prof. Langley of the possibility of obtaining the desired thrust needed with an air propeller.

Such, then, is the record of the only attempt that has been made of moving a car upon a railroad track with an air propeller, and the slight contribution that it made to the art of aerial navigation by heavier-than-air machines, in the course of the epoch-making investigations by Prof. Langley.

The Caprotti Valve Gear

General Description of a New Valve Gear in Use on the Italian State Railways

It is safe to assume that as long as steam locomotives are in use, inventors will be at work in attempting to improve the steam distribution and lessen fuel consumption. One of the latest aspirants for honors in this field is Mr. A. Caprotti, who has designed a valve gear that has been placed on a number of locomotives of the Italian State Railways.

The valves used are of the lift type and the power required to move them is obtained from cams driven by a shaft that is connected by bevel gears with one of the driving axles.

By the use of this method of driving inertia effects are eliminated and a lighter gear is obtained than with the ordinary Walschaerts construction. A quick opening and closing of the valves is also obtained and the clearance volume is reduced to a minimum.

Four valves are fitted to each cylinder; two for the exhaust and two for the admission. To operate these, three cams are used: two for the two admission valves and one for the two exhaust valves, and all are set upon a single rotating shaft running crosswise through the steam chest. There is a multitude of parts and connections for the operation of the valves, including springs, guides, bell cranks and levers, which it is unnecessary to describe or illustrate in order to obtain a clear idea of the method of operation; the essentials of which can be readily understood from the diagrammatic illustrations that are given.

Fig. 2, is a plan view of the mechanism in the steam chest, and 1 is the rotating shaft upon which the cams *A*, *B* and *C* are mounted.

The single cam *A* controls the movement of both of the exhaust valves, and it is so arranged that the exhaust openings and closures occur at the same point of the stroke in both forward and backward gear, regardless of the point of cut-off. The means of accomplishing this is shown in Fig. 3.

There are two bell-crank levers 2, 2, the ends of whose long arms rest upon the upper end of the valve stems. In actual construction these stems are fitted with helical springs by which the valve is held, normally in their uppermost and closed position. There are rollers on the ends of the short arms of the bell crank that bear against the face of the cam *A* which is of the shape shown. It has a circular slot in it by which it is driven by a lug on the rotating shaft 1. When the engine is moving forward the lug engages one end of the slot and thus adjusts the cam for the proper opening and closing of the two ports. When the engine is reversed, the cam remains stationary until the lug engages the other end of the slot whereby the cam is automatically set for operating the exhaust valves with the engine reversed. So that when running in either direction the exhaust cam setting is fixed and cannot be varied.

In the case of the admission and cut off the two cams *B* and *C* work in combination and provide a compound motion for the admission valves. This compound motion is very similar in the matter of mechanical detail to the single cam, and roller for the exhaust, except that the latter is replaced by two rollers on a pivoted lever.

In the engraving Fig. 1, one cam is shown in full lines and the other by dotted, and one of the rollers referred to bears against one cam and the other against the other, so that the movement transmitted to the valve is a combination of the movement of these two rollers.

This double cam arrangement makes it possible to alter both the lead and the point of cut-off. The admission can be more or less advanced by changing the angular position of the cam *B*, while the cut-off is varied by altering the position of the cam *C*. These two movements are secured in a way which provides for a small change in the position of *B* while there is a large change in the position of *C* or *vice versa*.

This is obtained by having the cross-shaft on which they are set, cut with a very long pitch four-threaded screw. Meshing on this screw are two wide-rimmed discs *D* and *E*, which are coupled to the two cams respectively, so that the latter have the same angular position and the same rotary motion as the discs to which they are attached. The cams have a constant location longitudinally on the shaft, and as the discs are moved to and fro over the threaded portion they are given a corresponding angular motion. The motion is transferred from *D* to *B* and from *E* to *C* through two pairs of rods, which slide back and forth in slots in the discs.

The discs are surrounded by straps after the manner of eccentrics to which the rods by which they are moved to and fro are attached. The method by which a variation in the movement of the two discs is obtained is illustrated by the dotted diagrammatic sketch at the right of Fig. 2.

It will be seen that, for the same angular movement of two crank arms in the direction indicated by the arrow, a greater longitudinal movement will be given to the disc *D* than to the disc *E*. While if the crank arms are moved in the opposite direction, by which the engine will be reversed, the opposite will be the case. These crank arms are set at an angle of 110 degrees with each other.

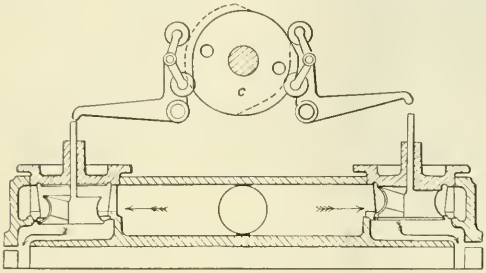


FIG. 1.

If then, the crank arms are turned in either direction the two discs are separated or brought together and turned by the threaded portion of the shaft in proportion to the distance moved.

In reversing there is a change in the functions of the two cams. Thus the cam *B* which, in forward running governs the admission, in reverse running controls the cut-off; while *C*, which is the cut-off cam for forward running is the admission cam in reverse. This gives a control of the steam events similar to the Stephenson gear in that as the cut-off is shortened the pre-admission is advanced and the lead increased.

The effect of the quick opening and closing of the lift valves is quite apparent in the indicator cards. Three of these are given in which the cut-off was 3, 15 and 25 per cent of the stroke respectively. The effect of the quick opening and pre-admission is shown in the rise of pressure, at the beginning of the stroke, above that of the steam chest. While the effect of the wide open port and the quick closing is shown in the comparatively straight admission line as compared with the three cards taken with a Walschaerts gear on a similar engine. Though the two are not strictly comparable because of the differences in the points of cut-off.

A number of test runs have been made with engines of identical dimensions, one having the Caprotti and the other the Walschaert's valve gear. The general dimensions of these engines were as follows:

Diameter of cylinders, 21 in.
Stroke of piston, 27½ in.

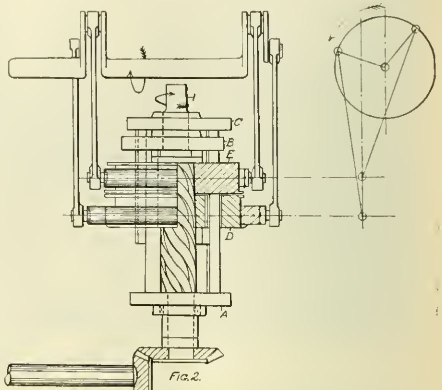


FIG. 2.

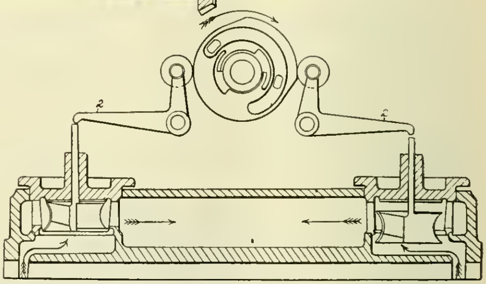
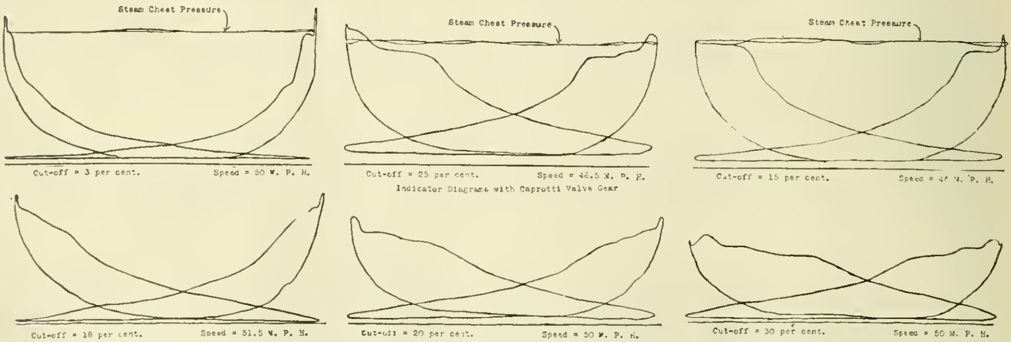


FIG. 3.

Diameter of driving wheels, 52½ in.
Weight on drivers, 123,200 lbs.
Total weight of engine, 145,200 lbs.
Total weight of tender, 88,000 lbs.
Total heating surface, 1,644 sq. ft.
Grate area, 30.13 sq. ft.
Super heater surface, 443½ sq. ft.

The distances run in these tests were 93 and 15½ miles respectively, return trips having been made over the



Indicator Diagrams from Locomotives Equipped with Walschaert's and Caprotti Valve Gears

93-mile run. The average results are given in the accompanying table.

Disregarding the number of trips and dealing only with the averages we obtain the following ratios. The engine equipped with the Caprotti gear did 21.45 per cent more work when measured in foot pounds, than the locomotive fitted with the Walschaerts gear and did it on 13.75 per cent less in water consumption and with 17.65 per cent less coal. If these savings are equated on the basis of work actually done they amount to a saving of 30.77 per cent of water and 33.91 per cent in coal, which results would sustain claims made for its merits.

Work Done by Locomotive With Caprotti Valve Gear.

Distance Miles	Load Hauled Tons	Running Time	Aver. Speed M.P.H.	Work Done at Drawbar Million Ft. Lbs.	Drawbar Pull Lbs.	Horse Power	Water Consumption Pounds			Fuel Consumption Pounds	
							Total	Per H.P. at Drawbar	Per I.H.P	Total	Per H.P. at Drawbar
93*	321	3 hr. 54 m.	27.34	2,617.80	5,346	394.3	33,242	27.61	16.46	4,983	3.74
93†	355	3 " 15 "	28.64	2,126.40	4,323	336.0	29,172	26.71	16.83	4,180	3.83
15.5	172	45 "	20.83	821.28	10,006	564.0	13,944	32,98	14.72	2,075	4.91
Work Done by Locomotive with Walschaerts Valve Gear											
93*	282.0	3 hr. 30 m.	26.70	2,300.3	4,675	338	39,996	33.88	19.55	5,907	4.51
93†	304.5	3 " 28 "	26.97	1,500.1	3,784	298	32,450	33.88	19.94	5,280	4.79
15.5	160	55.5 "	16.86	765.4	9,332	427	16,078	40.66	17.56	2,460	6.34

* Going † Returning

Running Repair Practices in Car and Locomotive Shops

A Report Presented at the Convention of the International Railway General Foremen's Association

Running repair costs on locomotives are controlled to a great extent by the roundhouse foreman or the foreman directly responsible for the repair work. The management of a railroad can assist materially in reducing running repair costs by the regular assignment of locomotives, as this is an incentive to the engineer to be more painstaking in taking the proper care of his engine, more careful in its operation and more diligent in making out his work reports. When it is found that maintenance cost is high it always develops that the record could be considerably bettered by assigning engineers to regular engines wherever practicable to do so. When it is found necessary to transfer an engine from one district or division to another, instead of taking the oldest man's engine the youngest man's engine should be taken as this would only effect one man, whereas taking the engine of the oldest man it would naturally effect the men all the way down the line. This change of assignment would result in increased maintenance and would, by sequence, increase the running repair cost. Of course, however, in making such transfers general condition, type of engine required, etc., must be given consideration.

The committee finds that the railroads have various classifications of repairs for their locomotives. Some railroads require freight locomotives to make eighty thousand miles, passenger engines, one hundred thousand to one hundred-twenty thousand miles between shopping period. Others use a classification of repairs known as Class Nos 1, 2, 3, 4, 5 and running repairs, as follows:

Class 1. New boiler or new back end. Flues new or reset. Tires, turned or new.

Class 2. New firebox, or one or more shell courses or roof sheets. Flues new or reset. Tires turned or new. General repairs to machinery and tender.

Class 3. Flues all new or reset (superheater flues may be expected). Necessary repairs to firebox and boiler. Tires, turned or new. General repairs to machinery and tender.

Class 4. Flues part or full set. Light repairs to boiler or firebox. Tires, turned or new. Necessary repairs to machinery and tender.

Class 5. Tires, turned or new. Necessary repairs to boiler, machinery and tender, including one or more pairs of driving wheel bearings refitted.

Running Repairs. Unclassified.

(General repairs to machinery will include: driving wheels removed, tires turned or changes, journals turned, necessary, and all driving boxes and rods overhauled and bearings refitted and other repairs necessary for a full term of service.)

The latter classification is used more in accordance with filing of semi-monthly report of engines held and turned out during previous period. With the modern power now in use and the high standard of running repair maintenance the above mileage should be easily obtained under either classification.

At almost every roundhouse repair work is sometimes reported which it is almost impossible, or at least not practical, to take care of at the time due to certain conditions existing. The foreman in these roundhouses maintain what might be termed a "Suspense Book" covering the items of incompleted work and proper notation is also made on back of the work report explaining why the work was not taken care of. However, unless the roundhouse foreman is very alert and does not lose sight of these items, repair work will be neglected to such an extent that it will develop from a small job into a large undertaking. Practices such as these are very contagious, and if allowed to continue soon become epidemic. If running repair costs are to be reduced certain work should be done as soon as reported. Locomotive maintenance should not be deferred any more than is absolutely necessary.

It is the practice at some shops to maintain their roundhouse running repair gang separately. These men specialize in certain classes of work. Some specialize on injectors, cab and air work; some on rod work and others on various other work, unclassified; in fact all items of repairs that are chargeable against running repair costs. Foremen must be fully acquainted with charges that constitute running repair maintenance. Otherwise they are likely to approve work being performed which is not directly chargeable to running repair maintenance. Various railroads have different systems of classifying their repairs. However, in the opinion of this committee, running repair classifications should only include hot work or work to be performed on a locomotive between layover trips. All labor and material expended on this class of work is chargeable to running repair costs. The average maintenance per mile is then arrived at from the total amount of engine mileage made as compared with the total money spent on running repair maintenance. Keen competition should exist between the foremen toward bringing their running repair maintenance cost down, as this is one of the features of mechanical operation that the management of every railroad company analyzes very closely, and if the foremen in charge allow the handling of shop cards or time slips to be taken care of by an assistant and do not personally check the various charges occasionally, it is useless for them to expect to keep running repair costs anywhere near normal. A good barometer for the roundhouse foreman to compare his running repair cost or get an idea as to his running repair efficiency is to take a certain class of locomotive and base running repair cost per mile against the amount of money necessary to repair this engine while undergoing classified repairs. This could easily be determined by taking an engine in for heavy classified repairs, taking the cost of making this classified repair, minus whatever addition and betterment feature is involved and base it on shopping mileage. This would give the foreman a fair idea as to how his engines were being maintained between shoppings. In other words, cost can be determined on general repair mileage basis as against running repair maintenance on per mile basis.

Running repair costs will fluctuate in most any roundhouse unless the foreman has the handling of running repairs systematized to such an extent that it will absolutely preclude the possibility of any classified repairs entering into this cost. The foreman in charge should check work operations daily and should also make periodical checks of the distribution shown on time slips by the various mechanics with the timekeeper to know beyond a doubt that running repair costs are not being overcharged. This check only requires a few minutes of certain days and time consumed would more than justify itself by results obtained.

No fixed rule can be established nor can any fixed instructions be issued outlining definitely running repair costs as it is strictly in the hands of the foreman himself to handle and he can do this by close supervision, personal contact with the men handling the various repairs and having them understand the quantity and quality of work expected from them. If this is followed up closely the results obtained toward reducing running repair costs would manifest themselves.

Running Repair Costs on Freight Cars

Running repair costs on freight cars are handled differently than on locomotives. There is no segregation of accounting, all work performed being charged merely to "Freight Car Repairs." Cars arriving in train yards requiring repairs are handled according to the nature of repairs required. Certain classes of repairs on freight cars are made without cars having to be moved to rip track or repair track; other repairs make it necessary to move cars to rip track, while still other classes of repairs make it necessary to move cars into the shop. However, in railroad parlance, the rip track is the roundhouse of the car department and it is on the rip track that running repair work is taken care of.

Below is given a list of items of repairs which this committee believes is a fair basis to determine or outline what should constitute a running repair to a freight car:

Uncoupling attachments repaired.
Grab iron renewed or repaired.
Brasses applied.
Brake shoes renewed.
Running boards repaired.
Brake connection and lever.
Side door rehung.

(Any one or more of above items or similar thereto constitute running repairs.)

Of course, freight repairmen should be imbued with the idea of keeping down running repair costs on freight cars as much as possible by using second-hand material where they can, but this practice should not be encouraged when repairing foreign cars as to be reimbursed for work performed on cars belonging to other railroads it must be handled on the basis of new work.

Running Repair Practices in the Locomotive Department

The running repair costs and repair work practices in the locomotive department are so closely aligned with each other that they can be analyzed from either angle; that is, the running repair costs are governed by the practices and running repair practices govern the costs.

Running repair practices on various railroad should be approximately the same, with one idea paramount, and that is to take care of every existing defect that is reported on the work reports just as soon as it is reported, and where it is found necessary to defer some of the work and put it on the suspense book, to take care of this work at the earliest possible opportunity; however, as previously stated, this committee does not believe it a good practice to defer maintenance any more than is absolutely essential as deferred maintenance soon results in engine failures and delays on line of road. One of the first resolutions a foreman should make in connection with repair work practices is to make repairs when needed and when reported. This will have a tendency to minimize the maintenance cost and at the same time keep up the maintenance. The foreman should be made to realize that this is a dominating factor in repair work practices. Roundhouse repair work is a phase of operation that should be closely watched in conjunction with the volume of traffic being handled, as the greater the volume of traffic and the less time engines will remain in roundhouse and the less time the roundhouse organization will have for making repairs. This, in itself, is a conclusive argument deferring necessary repair work.

Foremen should outline their procedure of operation as to how the various repairs are to be handled and should have their men placed that they will be accustomed to handling the work so that they will prove of valuable assistance instead of a detriment in the turning of engines with as little mechanical delay as possible.

The foremen, to increase the efficiency of their man and enable them to properly analyze repair work practices, should make comparison of man hours consumed in performing various roundhouse operations. Man hours is a check instituted solely for the purpose of comparing or measuring results obtained during one period or on one kind of work compared with another period or for a similar operation. Generally speaking, man hour comparison is a very sound basis for figuring the efficiency of one man compared with another or one performance compared with another in the same line of work. Therefore, it is quite obvious that careful analysis of man hours is necessary from time to time to keep proper check an repair work practices and the efficiency of the employes.

The most tangible recommendation that this committee can make for regulating repair work practices in the roundhouse and securing the best results is to try in every respect to comply with the rules and requirements of the Interstate Commerce Commission in the handling of locomotives, boilers and their appurtenances, as strict compliance with these regulations will insure efficient practices and considerably lighten the burden of the foreman.

Running Repair Practices in the Car Department

Running repair practices viewed from the car department standpoint hinge principally on the proper handling and charging out of the various work performed. When repairs are made to a foreign car, except as provided in A. R. A. Rule 108, or on any car on authority of defect card, a book should be used and record of the repairs entered into same. From this book the repair card should be made and utilized. The book record referred to above should embody minimum information required for proper preparation of the billing repair card. When making repairs to cars in a train yard or on rip track or in the shop, the following requirements must be observed in recording repairs in the original record book.

1. Cars shopped for repairs must be carefully inspected by authorized employe before work of repairing is begun. All work authorized by this employe must be entered upon the original record, which is a book mentioned in the preceding paragraph, including the location of each item of repairs and exact reason or cause for making the repairs. This information must not be assumed but must be determined by an actual inspection. The common terms, broken, bent or missing, if used, when caused by derailment, cornering, sideswiping or other causes shown in A. R. A. Rule No. 32, must be qualified to show such cause.

2. The original repair record book must be signed by the authorized person making repairs at the end of each day's work.

3. All corrections made on the original record must be made by the person or persons who have vouched for the correctness of the original record by their signature. These corrections must be made by scratching through the incorrect information, and there must be no erasures.

In shops where such repairs are made other than running repairs a book of much larger dimensions than that used for running repair record to permit showing considerably more information should be used.

When repairs of any kind are made to a foreign car, billing repair card must be furnished car owners except as otherwise provided in A. R. A. Rule 108. This card must specify fully the repairs made, reason for same, the date and place where made, also show location of parts repaired or renewed as per A. R. A. Rule No. 14. Billing repair card should be made in duplicate to be known as the record repair card.

Employes making running repairs to freight cars, when entering record of same in repair book, must be absolutely certain that correct information is shown. The A. R. A. Association maintains a corps of traveling inspectors, as well as those employed by the various railroads, whose duties are to visit the various terminals and check the repair records. In addition to checking the records, these inspectors sometimes go out to the car to verify repairs shown in record book in order to determine whether or not proper entries are being made. Such a close method of checking and the iron-clad instructions in effect on practically every railroad against making improper charges of repairs makes it hardly possible for any false entries to be made by the repairman, and if any are made the employe guilty should be immediately and permanently removed from the service.

Running repair practices in the car department vary so greatly that it is a difficult matter for this committee to outline any definite procedure or practice. Some car inspectors are stationed at points where there are practically no facilities; others are stationed at large and small terminal points, but repair work practices should be based in all instances on a thorough understanding of the A. R. A. rules, safety appliance rules, loading rules, tank car specifications and other instructions incident to the handling and repairing of freight cars. The repairmen stationed at small outlying points, however, are not in position to handle cars as expeditiously or make repairs as quickly as the inspectors or repairmen at the terminal point.

Through the medium of interchanges located on all railroads, foreign cars are continually moving to and coming from one railroad to another. Naturally, the handling and repairing of these cars must be governed strictly by the classifications and instructions laid down by the rules. Repairs on freight cars are either chargeable to the handling line or car owners. When repairs are necessary for which the handling line is not responsible care must be exercised in making the repairs to know that they are made properly so bill can be executed to cover and the railroad making the repairs reimbursed for the labor and material expended.

If wrong repairs are necessary to expedite the movement of a car account of its being under load or account of not having the proper material in stock the car should be so carded at point at which wrong repairs are made so when car arrives home proper repairs can be made and road making the wrong repairs billed.

One practice we often find is that a car of manifest or other important loading will be bad ordered on line of road: temporary or wrong repairs are made to the car to get it to its destination. Car reaches destination and is made empty on home line or possibly will pass through an interchange to an interline switching road for belt movement to be delivered to an industry on their track where it is made empty and returned. When car is offered back to home line defect card is demanded from delivering line. Upon investigation it very often develops that the wrong repairs have been made on the railroad demanding the defect card. Some system should be put into effect to definitely designate on what road wrong repairs are made in instances of this kind as it will greatly facilitate car movement on the interchanges.

Another item that should be given consideration in discussing running repair practices in the car department is cars arriving in train yards in damaged condition. The A. R. A. rules state that it must be definitely determined in handling damaged cars whether owners or handling line is responsible. Should there be any doubt as to whether car was derailed or was in a collision, foreman in charge should trace record of the car to point where the damage occurred in order to ascertain whether repairs should be made at the expense of the owners or the handling line.

The few practices referred to above are in the minority compared with the many practices that obtain in the handling of freight cars and this committee respectfully suggests that those interested in car department repair work practices analyze the various rules pertaining to this particular line of work as the committee does not feel it could improve on the code of rules established covering repair work practices in the car department by the American Railway Association.

The committee that presented this report consisted of J. N. Chapman, chairman; B. O'Donnell, M. J. Gunther, W. S. Buntain and W. H. Kean.

The New and Future Developments in Steam Locomotives

Reflected in Series of Short Papers Before the New York Railroad Club

Recent designs and possibilities for further development in steam locomotives was the subject of a series of short papers at the New York Railroad Club's January meeting. These papers or discussions were all contributed by men prominent in the field of locomotive engineering and dealt with the characteristics of recent developments in that field together with possibilities for further development in the immediate future. Abstracts of these papers follow.

The Purpose of the "Horatio Allen" and Some of Its Performance Records

By JOHN E. MUHLFELD
Consulting Engineer

The railroad managers today have many fashions to select from in their choice of motive power. In addition to the established single-expansion two-cylinder, and Mallet multiple-expansion four-cylinder locomotives, there are now available for investigation the single-expansion four-cylinder Mallet; "50 per cent cut-off" single expansion cylinder; single or multiple expansion three-cylinder: Uniflow and Two-Flow cylinder; Krupp, Zoelly, Ljungstrom and Ramsay turbines; the Still engine; and many other steam innovations and combinations, to say nothing of the electric and internal combustion locomotives and many different kinds of self-contained motor cars. Last, but not least, there is also the high-pressure steam locomotive with any sort of wheel, cylinder, valve motion, superheater and feed water arrangement desired. If the steam and mechanical engineers continue in their efforts to harness the B. T. U. we will soon be as badly off, and probably lose as many of them, as our electrical friends.

The problem on the Baltimore and Ohio in 1902 was neither the fast movement of freight nor fuel economy, as in the Canadian Maritime Provinces, but rather the hauling of heavy trains over mountain grades. For that reason a Mallet Articulated Duplex Compound 0-6-6-0 type of locomotive was decided upon as being most suitable.

At this point it may be of interest to refer to the large number of multiple expansion locomotives of the four-cylinder, two-cylinder cross, and two-cylinder tandem compound, but not of the Mallet, types that were built in the United States commencing with about 1889. Disregarding the question of indifferent design, I am of the firm belief that had the use of the superheater been inaugurated in this country as early as it was used abroad, and prior to the advent of the compound large unit locomotive, the latter would still be in use, as the troubles due to excessive condensation in the low pressure cylinders would not have occurred. Further than this it was always found possible to get a fireman to "double back" out of a Divisional Terminal on a compound, but not so with the converted simple engine on account of the greater fuel consumption and harder steaming of the latter and more time and trouble required to start trains out of yards and sidings.

The particular reason for building the "Horatio Allen" is to learn as to just how much can be accomplished in overcoming the deficiencies of the single expansion locomotive by various changes in design, higher boiler pressure, multiple expansion, and waste-heat feed water heating, investigations relating to the latter feature and reheating of the receiver steam being still under way.

In designing the "Horatio Allen" the Consolidation type of locomotive has been adhered to for the purpose of continuing the simplest design and securing all possible adhesive weight, which latter has actually worked out to be 86 per cent of the total engine weight, with the possibility for further substantial increase in future construction. The idea has also been to reduce the amount of coal fired to within the comfortable capacity of the average fireman, instead of to apply mechanical devices to deliver a larger amount of fuel, at least until such time as powdered coal burning equipment can be installed so that the fuel can be automatically burned in suspension the same as oil.

Among the features of the engine to which especial attention may be called is the duplex throttle valve, consisting of a low pressure valve which admits steam at 300 pounds to start the engine, and a high pressure valve which admits steam at 350 pounds for running. The throttle lever rigging in the cab is interlocked so that the low and high pressure throttles are co-ordinately opened and closed.

The smokebox is equipped with a cast steel ring riveted to the shell, which is fitted with a single large door opening through which all flue, tube, superheater, and other parts can be removed.

In the operation of the locomotive, the engineer opens the low pressure throttle valve, and live steam is admitted to both high and low pressure cylinders, until, after starting, sufficient exhaust steam from the high pressure cylinder accumulates in the receiver, when the intercepting valve automatically stops the flow of direct pressure steam to the low pressure cylinder and the engine then operates multiple expansion. Shortly after starting, the high pressure throttle valve is opened to running position, and at the same time its operating lever picks up the low pressure throttle valve lever, so that when the high pressure throttle valve is closed, the low pressure valve automatically closes with it and when both valves are closed, the low pressure throttle valve lever is again automatically released so that it can again be independently operated for starting purposes.

The general idea has been to eliminate from the modern conventional steam locomotive a lot of the inaccessible and complicated running gear, machinery and accessory equipment, and to obtain more direct power and economy through a greater utilization of the heat in steam of higher pressure, generated in a boiler which will dispense with the existing type of firebox and combustion chamber with its combustion and spark losses, scale and sediment collecting sheets, limited firebox heating surface, sluggish circulation, stayed radial and flat sheets, and numerous other parts subject to leakage, breakage and failure, and thereby make the steam locomotive a more comfortable job for the engineer and fireman and put it in position to keep its proper place as the most effective and ecoonmical motive power for the movement of heavy tonnage over long distances, until such time as the production of power at a central point, or a more efficient and useful self-contained propelling unit can be produced.

The actual designing was commenced during 1919 and continued until, by the elimination process, final conclusions were reached in August, 1922, when the American Locomotive Company was authorized to proceed with the construction of what is now the "Horatio Allen," and which construction was completed during June, 1924. After the details of the boiler design were developed there was considerable skepticism and criticism on the part of the builders with respect to various features, with the result that two of their representatives, Messrs. Mellin and Wilson, were sent abroad during November, 1922, for a conference with the officers and engineers of Messrs. Yarrow and Company, Ltd., Glasgow, Scotland. The fact that not a single change was made in the design of the boiler, as the result of this investigation, is evidence of the thought that had been given the subject.

With respect to the total weight of the sample locomotive, this may properly be criticised as being high. However, my experience has been that it is better to have too much weight in motive power and keep it in useful service, earning money, than too little weight and have it in the back shop or enginehouse spending money and tieing up traffic. This, however, is no alibi for indifferent design or calculations.

The engine weighs 36,000 lbs. more than the original estimate, an increase that is due to the radical design of the boiler and other machinery features offering no precedent for guidance, as well as to the relatively high factors of safety that were used, with particular reference to the boiler, cylinders, frames and machinery. With the experience gained from construction, testing and operation of the sample locomotive, the over-all dimensions can now be compressed and the weights can be substantially reduced. Furthermore, the distribution of the total weight over the leading truck and the driving wheels can be better equalized.

Even with the weights as they exist, the dynamic augment, at a speed of 30 miles per hour, as well as the static loading per pair of driving wheels per lineal foot of track, comes well within present-day steam locomotives of the Consolidation, Decapod, Santa Fe and Atlantic types, and substantially below that of electric freight locomotives, where the axle loads range between 75,000 and 80,000 pounds. At any rate the "Horatio Allen" has as yet given no trouble in its movement over the line of road, and it is an exceptionally steady and easy riding locomotive.

It has been found that, when running 25 miles per hour or a piston speed of from 700 to 750 feet per minute, which is unfavorable from an operating standpoint, the combination of a moderate degree of superheat and multiple expansion has proven more economical than a combination of relatively high superheat and single expansion in other Consolidation type freight locomotives performing similar service at speed limits of from 35 to 45 miles per hour. The limit speed at which this more economical performance will obtain, by means of multiple expansion, remains to be determined.

It is too early to report the technical performance of the locomotive for the reason that the feed water heating and pumping equipment has not yet been applied, the final combustion, draft and steam distribution adjustments and other minor changes have not been made, the locomotive has not yet been indicated, and a full winter's practical performance experience is desired before any conclusions are reached, but the following information may be of interest at this time.

The outstanding feature of the "Horatio Allen," as a transportation machine, is its hill climbing ability and the speed at which it negotiates short or long heavy straight-way grades with maximum tonnage trains. With its running speed limited to 25 miles per hour, it makes the trip over the division in less time than the other superheated single expansion Consolidation type locomotives, which operate at from 35 to 45 miles per hour running speeds.

This sustained boiler and engine capacity of the locomotive in compound gear, when steam from the boiler is entering only one 23½" diameter high pressure cylinder, has been demonstrated by its hill climbing qualities during all its runs. For example, Richmondville Hill, south-bound, consists of an up-grade about 19 miles long with predominating grades of 1.42%, compensated. On October 18, 1924, the No. 1400 with 50 cars, 1,327 adjusted tons, car adjustment factor 5, with drawbar-pulls ranging between 40,000 and 31,000 lbs., made this run in about 50 minutes. The following tabulation shows the operation at the end of each mile for the last 5 miles of the 16 mile pull:

Mile post No.	Boiler Pressure, lbs.	Branch pipe pressure, lbs.	Receiver pipe pressure, lbs.	Temperature of steam branch pipe Deg. Fahr.	Drawbar pull, lbs.	Speed of miles per hour
50	345	335	92	590	47,000	18
51	345	330	90	590	44,000	18
52	345	335	92	595	46,000	17
53	345	335	92	595	46,000	17
54	345	335	92	595	48,000	16

The calculated tractive power is 70,300 lbs. in compound gear with a factor of adhesion of 4.25 and 84,300 lbs. in simple gear with a factor of 3.54.

On Schoharie Hill, north-bound, 75,000 pounds drawbar pull has been developed in compound gear with a receiver pressure of 97 pounds. When simple, and developing 95,000 pounds drawbar pull, the receiver pressure has in some cases gone up to 120 pounds.

The substantial increase in the actual as compared with the calculated drawbar pull is probably due to a combination of reduced loss in pressure between the boiler and the high pressure cylinder due to the dry pipe, superheater and branch pipe design; the liberal steam passages to and from the valve chests and cylinders; the long valve travel and large admission and exhaust openings; the large receiver capacity; and the relatively low cylinder back pressure, all of which favorably influence the mean effective pressure in the cylinders. Moreover, multiple expansion permits of a high ratio of expansion without excessive cylinder condensation and increases efficiency. Therefore, with the high pressure steam expanding from 340 to from 110 to 75 pounds in the high pressure cylinder, and from that to final pressure in the low pressure cylinder, there is much less thermal loss as compared with the single expansion of the steam in one cylinder.

The average time of the "Horatio Allen" to make the maximum tonnage train runs, between Oneonta and Mechanicville, during the existing weather conditions, is about 8 hours north-bound, and 6½ hours south-bound. From 8 to 9 tons of coal are now being used on the north-bound run, and, with the tender capacity of 14 tons, the run is made from Oneonta to Mechanicville (with fire cleaning and lay-over at that point) and return to Delanson, a distance of about 118 miles, without taking coal.

On the heaviest pull, about 50 minutes on Schoharie Hill, the coal consumption of the "Horatio Allen" is well within the range of comfortable firing for the average fireman, and but little over that of the smaller superheated single expansion Consolidations that take about 1 hr. 10 min. to make the pull and have a rating of 1,885 adjusted tons, as compared with 3,500 for the "Horatio Allen," which is over 85 per cent more.

In addition to the hauling capacity of the engine in compound and simple gear, there is also the reserve tender truck booster motive power which can be developed to utilize 60 per cent of the loaded tender weight, or a working minimum of 65,000 lbs., as adhesive power. This booster is now being operated at from 175 to 200 lbs. superheated steam pressure, which it is proposed to increase to 250 lbs. The boiler produces adequate steam to operate the engine simple in combination with the booster up to speeds of 7 miles per hour. However, the usual operation is to work the engine in simple gear, when necessary, to 6 miles per hour, then cut in the booster and work the engine compound up to a speed of 10 miles per hour, when the engine will run away from the booster, and the latter can be cut out. The cutting in and out of the booster engine is a manual operation by the engineer.

On November 2, 1924, the boiler was washed out at Oneonta enginehouse and the time required to complete the job was about 12 hours. The inspection at that time showed that the top drums, longitudinal and vertical water tubes and arch tubes were clean, while the bottom drums and the cylindrical shell had a light accumulation of mud.

The next wash-out was on December 6, 1924, at Oneonta. A record was kept of the time required to do the work which is shown as follows:

To remove wash-out plugs	1 hour
To remove man-hole covers in drums	1 hour
Putting water turbine through all water and arch tubes	6 hours
Reapplying man-hole covers	1½ hours
Reapplying wash-out plugs	1½ hours
Total time	11 hours

Inspection at that time showed that all parts were clean with the exception of a light deposit of sediment in the steam and water drums and in the bottom of the boiler barrel.

The disposition of the sediment as found in the boiler at wash-out periods is evidence that the boiler water circulation is very active, particularly through the vertical water tubes between the lower and upper drums. In general, the majority of the sediment equalizes in two zones in the cylindrical shell portion of the boiler and can be readily washed out through conveniently located wash openings.

The Pennsylvania System now has in service several hundred of their "50 per cent cut-off" Decapod type locomotives. The equipment of these locomotives is such as to enable the testing out of the Type "A" or top header superheater; the Type "E" or side header superheater; open type of feed water heaters; hand and stoker firing; and various other details of design, construction and equipment.

The 50 per cent cut-off advocates claim that on account of the more uniform torque approximating that of a three-cylinder locomotive, they have determined they can use a factor of adhesion of 3.5. While there is no doubt but that the auxiliary port permits a later cut-off at extremely slow speeds, at the same time this would appear to defeat the claim of the uniform torque approximating that of the three-cylinder engine. In other words, if the 50 per cent cut-off engine gives an equivalent cut-off of about 80 per cent, certainly some of the advantage in smooth turning movement due to shorter cut-off would be lost at the very time when it is most desirable to have it.

It is my understanding that further and more comparative tests of these Pennsylvania "50 per cent cut-off" Decapods are contemplated at Altoona, which should give us a good idea as to the relative efficiency and economy of the different combinations referred to above.

With respect to the three-cylinder locomotive—which is now receiving considerable attention—the locomotive builders, in 1905, brought to the attention of The Baltimore and Ohio officials the design of a single expansion engine of that type. We advised them that if they would build an engine with one middle high pressure and two outside low pressure cylinders, we would accept it as one of an order for 35 Pacific passenger locomotives, but the design never materialized.

I have never favored the three or four-cylinder single-expansion steam engine of either the single or articulated chassis type, on account of the additional complicated and highly stressed valve motion and power transmission parts and mechanism and the location, between the frames, of inside crank shafts, main rods, crossheads, guides and other inaccessible working parts and bearings.

Because of the advantages claimed for the three-cylinder single-expansion locomotive a number of railroads have placed orders for this type of locomotive. Of these I have followed the performance of the Lehigh Valley mountain type locomotive No. 5,000, put into service during October, 1923, which has 3—25" diameter by 28" stroke cylinders; 69" driving wheels; 200 pounds boiler pressure; superheater and stoker, but no feed water heater or booster; 246,500 lbs. on driving wheels; 122,500 lbs. on leading and trailing truck wheels; 64,700 lbs. tractive power; a factor of adhesion of 3.81; and 67 per cent adhesive weight.

During December, 1923, some test runs were made on the low grade portion of the line between Tifft Farm and Manchester, the ruling grades being 0.4 per cent.

The results of these operating tests, as reported, show average results per trip as follows:

1—Length of runs, miles	68.4
2—Length of runs, when working steam, miles	59.4
3—Length of runs, when drifting, miles	9.0
4—Speed when working steam, miles per hour	19.69
5—Cut-off, per cent of stroke	58.1
6—Indicated horsepower	2204
7—I.H.P., Maximum (middle cylinder, crank end)	409.9
8—I.H.P., Minimum (left cylinder, crank end)	34.39
9—I.H.P., different, max. over min., per cent.	19.2
10—Pressure, boiler (Pops set at 200 lbs.) Lbs.	189.9
11—Pressure, in saturated side of superheater header, Lbs.	184.0
12—Pressure, in superheated side of superheater header, Lbs.	178.1
13—Pressure, steam chest, Lbs.	175.0
14—Pressure, initial in cylinders, Lbs.	171.8
15—Pressure, back in cylinders at compression, Lbs.	15.0
16—Temperature of steam in branch pipe, deg. Fahr.	619.3
17—Temperature of steam in exhaust pipe, deg. Fahr.	322.7
18—Coal as fired, excluding auxiliaries, per I.H.P. Hr. Lbs.	2.64
19—Coal as fired, including auxiliaries, per I.H.P. Hr. Lbs.	2.72

From these test results the work produced from the heat put into the steam by the locomotive boiler and superheater and then used in the cylinders, or the heat utilization, may be illustrated as follows:

Heat input in steam	1326 B. T. U.
Heat used in work	135 B. T. U.
Heat lost	1191 B. T. U.
Efficiency	10.1 Per cent

As a matter of comparison, steam generated at 350 pounds pressure entering a single expansion cylinder at 340 pounds pressure with 150 degrees of superheat, and exhausted from the cylinder at 10 pounds back pressure, represents an input of 1299 B. T. U., an output in work of 224 B. T. U., a loss of 1,075 B. T. U., and a thermal efficiency of 17.2 per cent. Likewise steam generated at 200 pounds pressure, entering a single expansion cylinder at 185 pounds pressure with 250 (or 100 more) degrees of superheat, and exhausted from the cylinders at 10 pounds back pressure, represents an input of 1,333 B. T. U., an output in work of 193 B. T. U., a loss of 1,141 B. T. U., and a thermal efficiency of 14.5 per cent. Therefore, the combination of higher pressure and lower superheat produces 18.6 per cent more thermal efficiency than the generally used combination of lower pressure and higher superheat, without any allowance for the further efficiency than can be obtained from multiple expansion.

From these figures it would look as though the 200 lbs. pressure 250 degrees superheat single-expansion two cylinder locomotive should be 43.6 per cent more efficient, and that the 350 lbs. 150 degrees superheat multiple expansion two-cylinder locomotive should be 70.5 per cent more efficient, in the use of heat, as compared with the Lehigh Valley three-cylinder single expansion locomotive performance.

Theoretically, it would seem that the three-cylinder type of locomotive, with the cranks at 120 degrees, should have some marked advantages, namely, more uniform torque, increased starting power, and more rapid acceleration.

In good condition the three-cylinder engine with a factor of adhesion of 3.8 will, without a doubt, start and accelerate a light train quickly, but with full tonnage where operation at slow speeds at maximum capacity is necessary, and also on curves up to 25 miles per hour when full throttle is being worked, it is bound to be slippery. Likewise working the three-cylinder engine in short cut-off, with full throttle, as is the general practice with single expansion two-cylinder engines, will result in knocking in boxes and rods, and a correspondingly longer cut-off will be necessary. Valve, cylinder and rod packing; front and back-end main rod brass, particularly the middle cylinder; and crosshead and guide trouble, is bound to be increased. Furthermore, the wear on both the right and left valve motions will be reflected in the middle cylinder valve adjustment and make it difficult to keep all valves and steam distribution to the three cylinders properly adjusted.

Experience in England, on the Prussian State Railways, and in the United States, indicates that when the valve motion is new and in good condition and the mean effective pressure in the cylinders is well distributed, that there is a uniform torque. However, as the valve motion of the central cylinder wears faster than that of the three cylinders are connected to the same axle, and the torque become very irregular. Excessive driving axle strains and driving box wear are also experienced where the three cylinders are connected to the same axle, and the engines require more attention and repairs than two cylinder engines.

In general, the three-cylinder engine would seem to be better adapted to level or low-grade lines than to high-grade lines, unless the factor of adhesion is raised to at least 4, as on long, heavy mountain grades they must frequently be operated continuously for distances of ten miles or more at from 65 to 40 per cent cut-off, with from full to three-quarter, throttles, and at speeds of from 15 to 40 miles per hour.

In my opinion, if the three-cylinder engine is to succeed the factor of adhesion will have to be raised, and it will be of the multiple-expansion type and with a different arrangement of valve gear and power transmission mechanism for the middle cylinder than what is now being used in this country. But why three cylinders?

Commencing with the many advantages from the use of an outside type of valve gear as applied to the Baltimore and Ohio Mallet locomotive in 1903, I have been interested in keeping all possible machinery away from inaccessible and complicated locations, such as in the space between the frames, which is a good place for cross-ties and braces, as well as driver brake cylinders, receiver pipes and air reservoirs, if necessary, but not for reciprocating, revolving, sliding and wearing parts. Now, after over twenty years of effort in that direction, the designers and builders are commencing to put even more mechanism back into that undesirable location, and add not only to the profane vocabulary of the engine and enginehouse men, but to the maintenance and operating costs as well.

Finally reference should also be made to the experimental high pressure steam and multiple expansion work that has been done by Herr Wilhelm Schmidt and his associates as the result of which there is now under construction at the Henchels Works at Cassel, Germany, a multiple high and low pressure boiler and triple single expansion cylinder locomotive which it is proposed to have ready for service during the early summer. The boiler pressures will be 1100, 850 and 300 lbs., and the steam pressures for the cylinders 850 and 200 lbs.

Meeting the Demand for Increased Horsepower

By W. E. Woodward

Vice-President, Lima Locomotive Works, Inc.

Railway operating officers have for some time realized the importance of increased horsepower output from their locomotives as a factor in improving their operating conditions. This is known to them under different names. The operating man may see it in ton-miles per hour; it may become evident to him in increased speed of trains or increase in the number of cars per train, but every such increase means a decreased operating ratio and greater capacity for his line. It speeds up his operation.

A little over two years ago one of our largest railway systems received a locomotive which was built for them for trial purposes. This was tried out on several divisions for eight or ten weeks. Its operation was watched by the operating department as well as the mechanical department. At present there are over three hundred locomotives of this class operating on this road. The average freight train speed in one of the districts of this system before the introduction of the new class of locomotives was 12½ miles per hour. The new class of locomotives almost doubled this average with no decrease in tons per train. These engines became at once not only very well liked by the operating officers, but by the crews. It shortened their day's work.

Railways want to get such increases in ton-miles as I have just referred to. It means money to them. So, we are coming to a time when railway men will begin to think about the horsepower of their locomotives instead of their tractive power, because, after all, it is the horsepower that does the work.

For example, a locomotive giving 50,000 lb. tractive force at five miles per hour develops only 670 hp.; one giving 50,000 lb. tractive force at 15 miles an hour develops 2,000 hp. in the cylinders; 25,000 lb. tractive power at 45 miles an hour means 3,000 hp. It is the pull at speeds that counts.

What are the railway designers and the locomotive designers and builders doing about this? The use of higher steam pressure is one way in which this demand is being met. Another significant effort is the introduction of the three cylinder locomotive. There is another method that perhaps is not receiving as much thought as it ought to, and that is the use of limited cut-off in the cylinders to produce high horsepower. The use of the limited cut-off principle not only gives decided advantages in fuel economy at the lower speeds, but it results in very significant increases in capacity at the higher speeds.

So far, I have spoken of the developments which are in the engine end of the locomotive for the purpose of increasing the horsepower output. It is idle to design a fine engine and driving mechanism without proper means to feed it. There are many locomotives capable of producing 3,000 or more cylinder horsepower. This calls for at least 7,500 lb. of coal an hour and probably nearer 9,000 lb. When we come to burn coal at these amounts, it is the grate area that counts. It may be urged that it is only once in a while that the locomotive reaches its peak load, but as a matter of fact, under modern operating conditions engines are pushed to their limits for long periods. Not long ago on a test I was surprised to find that for over 45 minutes the locomotive was being operated at the rate of 135 lb. of coal per square foot of grate area per hour. I saw the performance repeated several times for shorter intervals.

Twenty-five years ago there was no considerable number of locomotives operating with trailer trucks. Grates were being pushed to their limits, sometimes burning coal at as high a rate as 200 lb. per sq. ft. of grate per hour. Trailer trucks were introduced; the wide firebox came into use and the limitation was removed. We have again come to the same point in the evolution of the locomotive; we have reached the limit of the grate which we can carry on a two-wheel trailing truck. We want more power and properly so. This means bigger grate areas. So we are ready for the next step, which is the four-wheel trailer and the big firebox.

My vision of the locomotive of the near future is one with high boiler pressure, cylinders capable of developing 3,000 to 3,500 hp., with a boiler and firebox which are capable of producing an adequate amount of steam for the cylinders in an economical manner. Such locomotives will have larger fireboxes than we are accustomed to use. The coal will be burned at a low rate of combustion, giving a high boiler efficiency. They will have large gas areas through the flues and tubes to match the firebox. They will produce these high horsepowers at relatively low rates of steam consumption. Such engines are not a dream; they will soon be here.

The Three-Cylinder Locomotive

By James Partington

Manager, Engineering Dept. American Locomotive Company

The requirements of the railroads and the problem of the locomotive builders at the present time is to produce locomotives which will haul heavier trains and which will haul those trains more economically and more efficiently. The history of locomotive development in the last decade, probably two decades, has shown that the limit of locomotives is primarily defined by what the railroads are permitted to carry in weight per axle. This has made it necessary for roads which have been operating with passenger locomotives, with four drivers, to increase to six drivers and eventually to increase to eight drivers; in freight service to increase from six to eight, in some cases to ten, and in other cases to have recourse to Mallet locomotives.

One point that I wish to stress is the particular advantage which the application of three cylinders, instead of two, has on this problem. The application of three cylinders can be employed in conjunction with all of the other improvements or adjuncts that are determined on as being necessary or advantageous or successful on present steam locomotives. The outstanding point of the three-cylinder locomotive is the fact that the torque curve of the locomotive is considerably smoothed down by the application of the power at an angle of 120 degrees. For example, in a two-cylinder locomotive which, for the sake of easy figures, has say a mean tractive effort of 40,000 pounds at one point of the torque curve, that tractive effort may rise to 50,000 pounds, and if the engine is slippery, or slips at that point, this determines that the weight on drivers must be a certain amount; ordinarily four and a quarter times the maximum tractive power giving a factor of adhesion of four and a quarter—that is, the total weight on drivers being equal to four and a quarter times the tractive power of the engine. When three cylinders are employed, the torque curve is smoothed down to a considerable extent. The same cylinder effort of a mean tractive power of 40,000 pounds has a high point in the torque curve of probably 43,000 pounds. This makes it possible for the factor of adhesion to be considerably reduced; and operating under the same conditions, with the same efficiency of the operator, you can reduce your factor of adhesion roughly from 4.25 to about 3.7 and obtain equally good traction results. This is of great importance today because the limiting factor on most roads is the allowable weight per pair of drivers. In fact I think it can be almost said that that is the limiting factor on all roads today.

The next item which is along the same line as the limiting factor being the maximum allowable weight on driving wheels, is that with the application of three cylinders the dynamic augment can be very materially reduced for a locomotive of like power. The engineers of the country today are realizing more and more that their track conditions must be studied, not only from the standpoint of the static weight of the locomotive, but from that of the combined static weight and dynamic augment. The use of outside cylinders, somewhat smaller in the three-cylinder than the two-cylinder locomotive makes is unnecessary to have as great an amount of unbalanced counterbalance to take care of balancing the reciprocating parts. Thus, the amount of counterbalance in the drivers in excess of the revolving weight, which is the disturbing element, and which produces the dynamic augment, is very considerably reduced in the three-cylinder locomotive.

Another point, which bears to some extent on the size of the firebox, is the effect of six exhausts instead of four to one revolution of the drivers. This is better in that it produces a more uniform draft on the fire and the fuel combustion is correspondingly improved. Of course the three-cylinder locomotive is not new. It has been built at different times in this country, and I think is coming into favor again at this time, largely on account of the fact that the weight on drivers is now the major consideration, the weight per axle being the limiting factor with most of our railroads.

Three cylinder locomotives are coming into service on a considerable number of our railroads, and it will probably be but a short time before much more definite data is secured than we have at this time. The fact that these locomotives show in performance, in comparison with two-cylinder locomotives, that they are hauling heavier trains than a comparison of the tractive powers would indicate they should haul, would seem to show that the application of three cylinders with some of the engine effort being applied at the center line of the locomotive rather than at a point very much overhung from the rail line is probably resulting in less engine friction that we have in two-cylinder locomotives. And it may be that results, when they are obtained to an extensive enough degree, will show that engine friction in three-cylinder locomotives can be computed at a lower figure than in two-cylinder locomotives. Three-cylinders are being applied on a number of different types of locomotives, and results will soon be obtainable from different classes of service. They are now in service on 8-wheel switching engines, on Pacific type passenger locomotives, on Mikados and on Mountain type freight locomotives, in fast freight service. They will shortly go into service on 4-10-2 type locomotives in heavy freight service, and this extensive installation on different roads of many different types will make possible, before long, more definite data in regard to the performance of the three-cylinder locomotive.

The McClellon Firebox

By W. L. Bean

Assistant Mechanical Manager, New York, New Haven & Hartford

Mr. Bean briefly described the new 4-8-2 type locomotive recently built by the American Locomotive Company for the New York, New Haven & Hartford Railroad, which is equipped with the McClellon type water tube firebox and cylinders with 70 per cent maximum cut-off. Two locomotives that have been equipped with this type of firebox for the past nine years have been giving satisfactory service and they require considerably less firebox work than the customary stayed type firebox. One of the principal alterations which experience with the two earlier locomotives has suggested is the use of a frame connecting the foundation ring and top drums to give greater structural rigidity. No difficulty has been experienced with the air-tight casing which encloses the water tubes and which is applied in plastic form, and over which the regular lagging and jacket is placed. Less radiation is apparent from this firebox than from the usual type.

Mr. Bean stated that the three-cylinder eight-wheel switching locomotive which has been in service on the N. Y., N. H. & H. R. R. has been giving very satisfactory service.

More Tests Would Aid Locomotive Development

By W. H. Winterrowd

Assistant to President, Lima Locomotive Works, Inc.

I wish to emphasize the importance of the relationship that exists between constructive locomotive development and economical and profitable railroading.

During the past two years, the railroads of this country have had to handle the greatest peak loads in their history. They have accomplished this with capacity to spare. How this has been accomplished is best known to those of you who are familiar with the work of the American Railway Association under the leadership and direction of Mr. R. H. Aishton.

As last year's transportation record proved that the existing plant of the railroads as a whole was adequate to handle all the traffic offered them, the question may be raised as to any necessity for super-power steam locomotives.

This question is clearly answered in this week's issue of the Analist in an editorial entitled "The Business Outlook." In that article the editor states:

"Last year's transportation record proved that the existing plant of the railroads as a whole was adequate to handle promptly all traffic offered. But the attempt to keep the percentage of net earnings up, in the face of declining gross receipts, has shown the saving capabilities of new equipment of many sorts: and especially the economy attainable by substituting new, more powerful, and more economical locomotives for many of those now in use. New and better motive power has resulted in the discarding of from two to ten or more old engines for each of the newer ones installed. There is thus a motive for railroad purchases of equipment which is independent of boom influences."

The possession of super-power steam locomotives will have no effect on gross revenue; but their value as money makers depends on their ability to cut down operating expenses, and that this is possible, emphasizes the importance of a full knowledge of locomotive performance in any and every consideration of a motive power policy.

New locomotives of increased capacity lend themselves easily to improved operating records. But mere increase in capacity is not enough. An efficient motive power policy demands that new locomotives should provide the greatest possible capacity with the greatest possible efficiency under the imposed conditions of operation. Is there any reason why those responsible for operation should not avail themselves of motive power that will earn a maximum return on the investment?

This brings up the question—Are the facts of general locomotive development and performance always available in such form that the railway executive has at hand prompt and dependable information on which to base his motive power policy?

It is my wish this evening to emphasize the importance of definite, reliable data regarding the efficiency, not only of the older locomotives but the modern, super-power types as well.

Is it unreasonable to suggest that after any new type goes into service, prompt and thorough effort should be made to ascertain scientifically and practically, the interest that they will return on the investment as well as what they make possible in the way of future development?

In this country there are several testing plants, that have all rendered excellent service, but I feel that you will agree with me that the information obtained and made public as a result of the tests on the Pennsylvania Railroad test plant has been of incalculable value to the railroads of this country in general.

The steam locomotive is entering a period of remarkable development. As we progress, let us ascertain without delay the scientific and practical facts. Sound and consistent progress depends upon it. There are many problems today awaiting solution on this basis. There are locomotive testing plants available upon which much valuable comparative information can be produced. There are also problems that can be solved in road test service, if the facts are obtained in a dependable way.

In conclusion, may I emphasize, not only the publicity that is desirable in connection with such facts, but the importance of them being presented in such manner that they are capable of intelligent interpretation in the light of efficient and economical railroad operation?

The Locomotive Boiler

By C. A. Seley

Consulting Engineer, Locomotive Firebox Company

It used to be that the bulk of the boiler water was not very far from the fire, but the increase in the number of wheels resulted in lengthening the boiler as well as increasing the girth. There is not much difference between modern locomotives and old ones on the ratios used for grate areas and heating surfaces in fire boxes and flues. The superheating equipment, while considered a part of the boiler, is not, in reality, a part of it as its work is done after the steam has been manufactured by the boiler heating surface.

The question of prime importance, however, is how to produce the most evaporation per pound of fuel. Its solution is nearly as important as that of maintenance for the amount of patching, repairing and renewal of boiler structure is a direct reflection of the stresses and strains set up while in use. We do not see locomotive type boilers in power houses. The water tube and other high evaporative types of boilers are built with a view to greater evaporation. They must do two things: make two steam bubbles grow where one grew before, and thoroughly mix the boiler water so as to reduce the sluggish water areas or temperature ranges to a minimum.

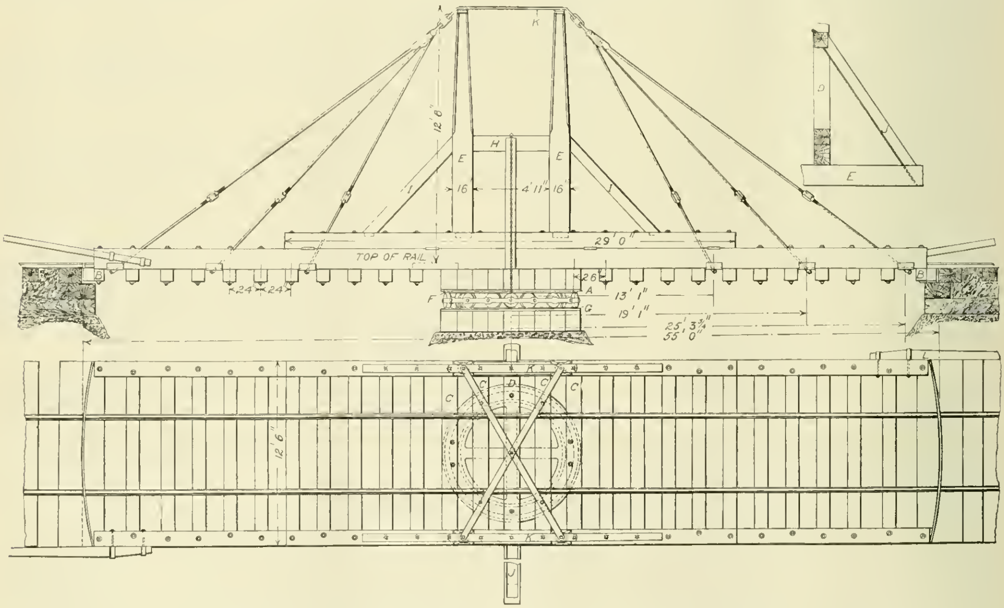
The element lacking in the locomotive type boiler is proper circulation. If proper circulation is provided it will act in three ways: first, it will induce greater evaporation because water is a non-conductor of heat which must be moved against a hot surface for heat transfer and evaporation; second, if the increased capacity is not usable, the coal rates will be proportionately reduced and thus fuel economy be obtained; third,, the circulation of the water in the locomotive boiler will result the same as in a water tube stationary boiler in obtaining a reduction of stresses as well as a corresponding amount of savings in work and expense.

It is desirable to have a boiler capacity of 100 per cent of the total cylinder capacity in horsepower, for the reason that the fuel, condition and personnel features of boiler operation are not always 100 per cent. By making use of proper water circulation, many locomotive boilers now in operation are designed with 80 per cent to 85 per cent of the total cylinder capacity, leaving the balance to be supplied by means of improved circulation, thereby affecting a saving in total weight of from 10,000 lb. to 15,000 lb.

One of the features of locomotives that use fuel oil is the fact that complete combustion is attained with no spark losses. The principal boiler loss in operations with coal fuel is the unburnt portion of the coal fired. It is estimated that there is a loss from this source as high as 48.5 per cent for coal rates of 185 lb. coal per sq. ft. of grate per hour and from 10 per cent to 25 per cent for 100-lb. to 120-lb. rates. This being the case, coal rates of 75 lb. to 90 lb. should not be greatly exceeded, which points to the necessity of having ample grate surface in order to give a basis for ample firebox volume. This may be reinforced with combustion chambers so as to shorten the flue and thus reduce the weight, as well as to compensate for loss in efficiency due to the change in design. Combustion chambers without adequate water circulation are apt to be a sore spot in maintenance. Special means of induced circulation around combustion chambers have been devised and are now in the process of development.

The Prairie Turntable

A good many years ago, when railroad equipment of all kinds was far less elaborate than it is today the Industrial Works of Bay City, Michigan, manufactured and put upon the market a complete knock down turntable or the iron fittings only by means of which a railroad company could readily construct a cheap and efficient turn table having a capacity of 150,000 lbs., and a track length of 55 ft. which was quite sufficient to meet any demands that were likely to be put upon it in its day and generation.



Old Prairie Type Locomotive Turntable as Made by Industrial Works

As will be seen from the illustration it was a timber structure, resting upon a roller-bearing center plate, and stayed by tension members attached to the top of four stiff unrights that rose to the height of 16 ft. 8 in. above the top of the rail, and were tied together at the top by an X frame of $4\frac{1}{2}$ by $\frac{3}{4}$ in. flat bars and the end bars K of $1\frac{1}{4}$ in. by 6 in. bars, which took all of the pull of the stay rods.

It is interesting to note the sizes of the timbers that were considered readily available. At the time this table was upon the market Bay City and Saginaw were in the center of the white and Norway pine industry of Michigan, and large sizes were at hand on demand. So in this case the main stringers were of 16 in. by 12 in. stock, spliced at the center for convenience of transportation but even with that calling for a length of 29 ft. 5 in. These were stiffened at the center with two 12 in. by 12 in. pieces spliced; the splices of the main stringers being 5 ft. 6 in. long and that of the stiffener 3 ft. 9 in.

The cross ties were of oak, 12 ft. 6 in. long, and 10 in. square and were bolted to the underside of the stringers by 1 in. bolts. At each end, at B, there was one measuring 10 in. by 16 in. At each side of the center there were two pine ties *C* measuring 12 in. by 16 in., while the one at the center was of the same size and 24 ft. long. This latter projected out for a distance of 6 ft. on each side and served as a footing for the brace J.

The uprights *E* were also 12 in. by 16 in. and were tied together by the beam *H* and braced by the struts I

The foundation consisted of a cribwork of 12 in. by 16 in. timbers set on a suitable base formed of piling or masonry; concrete having not yet come into its own. The pit, too, was of timber construction and the table was moved by the push bar *L*, the turntable motor being still a thing of the future. The whole structure, was, so far, a piece of heavy carpenter or bridge work.

The metal parts were as simple as the framing. There was a top center plate *A* that was bolted to the bottom of the ties *C* and *D*, then there was a top runway or center plate *F* which was bolted to the bottom of *A*, and on top of the foundation there was a bottom center plate and runway *G*. These runways were beveled to accommodate the beveled rollers of which there are 18 having a large diameter of 10 in. The bevel of the rollers and the center plate was depended upon to hold the table in its proper position.

The balance of the iron work consisted of washers and the stays, all of the latter of which had a diameter of $1\frac{1}{4}$ in. and were adjusted by turn-buckles. By this means the table could be kept up in alinement at all times regardless of settling foundations and shrinking timbers.

No outside circular track was provided. The ends of the strings, when level, were raised about 1 in. above the bearing timber in the wall, and when an engine was being run on or off, they moved down and came to a bearing there. This made perfect balancing a necessity, but this once achieved the table could be easily turned by hand.

John Fritz Medal Awarded to John F. Stevens

Award of the John Fritz Gold Medal to John F. Stevens of New York City "for great achievements as a civil engineer, particularly in planning and organizing for the construction of the Panama Canal; as a builder of railroads, and as administrator of the Chinese Eastern Railway," was announced here yesterday by the Engineering Foundation.

This medal was established in 1902 in honor of John Fritz, pioneer in the American iron and steel industry. It is bestowed annually for notable scientific or industrial achievement and is the highest honor bestowed by the engineering profession in this country.

The award was made by a board of sixteen representatives of the American Societies of Civil, Mining and Metallurgical, Mechanical and Electrical Engineers, having a total membership of 53,000.

John F. Stevens was born at West Gardiner, Maine, April 25, 1853, and while still a young man went to the Middle West, where he was active in railroad engineering for many years.

Mr. Stevens is one of the most widely known of American civil engineers. His name is associated especially with the Panama Canal, the American Railway Mission to Russia, and construction and operation of important railway systems in the United States. He is an honorary member of the American Society of Civil Engineers, and of the Association of Chinese and American Engineers.

Mr. Stevens, as head of the American Railway Mission to Russia in 1917-1918, contributed to the success of the allied nation in the World War. He was also Director of a Corps of Railway Experts in Manchuria. From 1919 to 1923 he was president of the Interallied Technical Board Supervising the Siberian Railways, bringing a notable measure of order into the chaos of the Siberian railway situation. While holding this office, with headquarters at Harbin, Manchuria, he supervised the technical and economic operation of the Siberian and Chinest Eastern Railway.

Mr. Stevens was chief engineer of the Panama Canal from 1905 to 1907 and in 1907 acted as director of the Isthmian Canal Commission. His organization of personnel of the Canal forces and especially of the transportation system contributed largely to the effective construction work on the Canal under his successor, General Goethals.

At various times in earlier periods of his life, Mr. Stevens was chief engineer, vice-president, and manager, of the Great Northern Railway, Chicago, Rock Island & Pacific Railway, New York, New Haven & Hartford Railway, and president, successively, of the Spokane, Portland & Seattle Railway and the Oregon Electric Ry.

Strathcona Memorial Fellowships in Transportation

Five Strathcona Memorial Fellowships in Transportation, of One Thousand Dollars each, are offered annually for advanced work in Transportation, with special reference to the construction, equipment, and operation of railroads, and other engineering problems connected with the efficient transportation of passengers and freight as well as the financial and legislative questions involved. Transportation by water, highways, or airways, and the appropriate apparatus involved, and also other general aspects of the broad field of transportation, embracing its legal and economic phases, will be included in the list of subjects which the Fellows may select for investigation and study. The holder of a Fellowship must be a man who has obtained his first degree from an institution of high standing. In making the award, preference is given in accordance with the will of Lord Strathcona, to such persons or to sons of such persons as have been, for at least two years, connected in some manner with the railways of the Northwest.

Applications for this Fellowship should be addressed to the Dean of the Graduate School of Yale University, New Haven, Connecticut, before May 1, on blanks which may be obtained from him.

Yale University has planned a survey of current investigations in various fields of transportation. Upon its completion it is expected that a stated program of courses of graduate instruction in certain phases of transportation will be regularly offered.

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Tonnage or Speed

It seems to have been proven beyond peradventure or at least many proofs have been forthcoming that it is more economical to curtail the tonnage of a train to some extent and move it at a somewhat higher speed than to run its tonnage up to the last ounce the engine can pull and drag slowly over the division in consequence.

As to just what speed will effect the greatest all around economy does not seem to have been perfectly demonstrated as yet. If recollection serves aright the late Dr. P. H. Dudley, after an elaborate investigation a few years ago, announced that a speed of between eighteen and twenty miles an hour was the most economical one for engine and train operation, but this is far from meaning that it is the most economical, all things considered, though it may be.

The point is that despatchers and superintendents, like other humans are frail and prone to succumb to temptation. And the temptation is to load the engine to capacity forgetful of the reckoning that will have to be met on the road in the way of delays and overtime. This is the story of many an increase of power. A passenger train has grown too heavy to be taken over the division by the locomotives in use. After consultation with the engineers a new machine is designed that will haul the train on schedule in fair weather and foul. Its performance is highly satisfactory and the lagging train begins to move on time. Then comes a time when the general manager's car is added to the rear, and still the schedule is met. That is all very well except for its demoralizing influence, for having learned that the extra car can be hauled, the extra car soon follows as the night the day; first occasionally then permanently, and so on until the engine is again regularly overloaded.

In freight the tendency is in the same direction and it is only by holding strictly to predetermined ratings that the situation is saved.

Overloading in switching service is a constantly flagrant offense. The engine is coupled to all the cars that it can move and hauls them at a snail's pace with slipping wheels and excessive wear and tear. Take a case recently observed. A switcher had twenty cars to move about a mile and a half. It was just all the engine could move at once and that mile and a half required 45 minutes to run, whereas the engine could have hauled half the load that same distance in about 12 minutes and returned empty in six. This would have made a total of 30 minutes for the transferring of the whole twenty cars, or a net saving in the time of the engine and crew of fifteen minutes.

The New Locomotive

There was a symposium on the locomotive at the January meeting of the New York Railroad Club, a brief review of which appears in another column, that was anything but pessimistic in its view of the future of the steam locomotive. In each of the papers submitted there was an air of confidence in the present situation, and a clear-cut assumption that the steam locomotive was not only not moribund, but was not even ill.

Each speaker had some concrete evidence to offer that contributed to the general opinion, though none claimed to have reached the final solution. It was an attitude of assurance that the locomotive would continue to develop in the future, as it had in the past towards greater economy in operation and efficiency in service. The high steam pressure proposed by Mr. Muhlfeld in the opening paper was received without comment or astonishment; and with not a trace of the misgivings that some can remember looking upon the jump made some forty-five years ago from a pressure of 125 lb. to 140 lb. per sq. in.

Mr. Muhlfeld naturally emphasized his latest design, the Horatio Allen, a description of which appeared in the January issue of this paper. His citation of some of the performances of this engine are already familiar to the readers here. He made no claims to having solved all of his difficulties, but only the minor ones of detail now remain to be met. The point is that he has made a jump from a steam pressure of 200 to one of 350 lb. per sq. in. has made modifications in his use of superheated steam, and has pinned his faith to a combined water and fire-tube boiler, that, so far at least, has justified his confidence in it.

But he was not alone in his advocacy of the water tube boiler, for Mr. Bean comes to the fore with an interesting story of the performance of the McClellan boiler on the New Haven, which has been in use for a number of years and has proven itself to be so satisfactory that a repeat order has been given for two more of the same type. From this it appears that the solution of that will-o'-the-wisp, the water tube locomotive boiler is in sight if not already to be listed among the things accomplished.

A few months ago these columns contained a description and illustrations of the three-cylinder locomotive designed by the American Locomotive Co. and they have also reproduced abstracts of papers by Mr. Partington and Mr. Blunt on the subject. And now Mr. Partington comes to us again with a general summary of the performance of this type of locomotive in service and a restatement of the structural and operative advantages connected with it.

But Messrs. Muhlfeld and Partington are not alone. They, to be sure, spoke of new designs, and of the economy and efficiency attendant thereon. Mr. Woodward spoke of the standard locomotive in a new dress. The 8,000 that was illustrated and described in RAILWAY &

Locomotive Engineering for August, 1922, was a new assemblage of familiar things. There was nothing in it with which we were not already familiar; but the regrouping of these standard appliances into a locomotive that has so fully justified its existence that, already, its replicas have passed the three hundred mark. Small wonder, this, when train speed has been doubled with no reduction of tonnage. And his vision of the future locomotive that, with a high boiler pressure, will develop from 3,000 to 3,500 horsepower does not seem likely to remain a vision for long, but to become a reality instead.

So here we have these prominent men in the locomotive field, each confident in the future of the machine to which he has devoted himself, presenting each a novelty that is an advance on common practice, and differing mainly in cylinder arrangements: the cross-compound, the three-cylinder and the standard two-cylinder, and all looking to a common goal of an increase in boiler pressure. It would be hazardous for a layman amid such an abundance to attempt to select the best.

But new designs did not have a monopoly of the evening's symposium. Mr. Winterwood makes the bare assertion that "the steam locomotive is entering a period of remarkable development," and then proceeds to outline the basis upon which this development is to rest. He does not think that a mere increase of capacity will be enough but that it must go hand in hand with efficiency, and urges that all information should be given the widest publicity, and that the locomotive testing plants should be worked to capacity.

Finally there was Mr. Seley, who emphasized the necessity of boiler efficiency. Of the desirability of active circulation and 100 per cent capacity, involving ample grate area and firebox volume.

So there we are. There was nothing in the whole proceedings that betokened the attempt to bolster a losing cause or add cheer to a forlorn hope. But the straightforward confidence of men who had implicit faith in the machines they are building, and a certainty that the future will be as bright as the progress of the past has been. There was nothing said that was derogatory to rivals in the field, which was seemingly regarded of ample dimensions to accommodate all comers. It was simply a hearty confession of faith, that did not allow for any backsliding but of a continued onward march of improvement into the indefinite future.

The Railroad Situation

The following extracts from the Annual Report of the Interstate Commerce Commission for 1924 gives briefly a reflection of the general situation of American railroads.

New railroad construction is not keeping pace with abandonments, although existing roads are constantly being improved by additional main tracks and yard tracks and sidings.

The substitution of larger cars and locomotives for retired equipment continues. From 1908 to 1923 the average tractive power of a locomotive increased from 26,356 pounds to 38,835 pounds and the average capacity of a freight car from 34.9 tons to 43.7 tons.

The calendar year 1923 marks the peak of railroad freight tonnage and ton-mileage.

The number of passengers carried in 1923 although larger than in the year preceding, was smaller than in 1913, 1914, 1916, and in each subsequent year, including 1921, but this relationship does not hold true of the passenger-miles because of the increase in the length of the average journey.

The growth in the length of haul per ton of freight reached its maximum in the year 1919, having been 309 miles in that year as compared with 300 miles in 1923 and 254 miles in 1908 (fiscal year).

The investment per mile of road continues to grow annually, but the rate of return from operations on the reported book value, which now exceeds 21 billions of dollars, shows wide fluctuations. That for 1923, 4.56 per cent, was the most favorable since 1917. Likewise, the net income after paying fixed charges, both in absolute amount and in ratio to capital stock, 7.06 per cent, was the largest since 1917.

For the year 1923, 62 per cent of the capital stock paid dividends, the average rate on such stock being 7.29 per cent. But if the amount of dividends is spread over all the outstanding stock, the average percentage falls to 4.52.

In 1923, as in 1920, operating revenues passed the 6-billion-dollar mark. While operating revenues were greater in 1923 than in 1920, operating expenses were nearly a billion dollars less than those of 1920. Maintenance of equipment expenses continue to absorb a much larger proportion of operating revenues than they did 15 years ago.

The average number of persons employed in 1923 by Class I steam roads was 1,855,260, representing a substantial reduction from the peak in 1920, 2,00,832, but an increase over the figures for 1921 and 1922. The compensation to employes was $3,004,083,599. This sum bears about the same relation to total operating expenses as obtained ten years before, but in relation to operating revenues the pay roll is a somewhat larger percentage than for 1913, although a decided reduction from the peak figure of 1920.

The average receipts per ton-mile in 1923 were 1.132 cents as compared with 0.729 cents in 1913, an increase of 55.3 per cent. In the same period, the passenger-mile receipts increased from 2.008 cents to 3.026 cents, an increase of 50.7 per cent.

Smoke Abatement at Grafton, W. Va.

The results of a smoke-abatement investigation conducted by Interior Department engineers at Grafton, W. Va., where property damage from bad smoke conditions was estimated at $300,000 annually, are outlined in Technical Paper 338, just issued by the Bureau of Mines.

Smoke conditions in Grafton, an important railroad junction, are influenced by a number of local factors that make the situation particularly difficult. The combination of high hills, low wind velocity, fogs, heavy railroad traffic, and the situation of the business district immediately adjacent to the greatest railroad activity, is probably not duplicated in any other railroad center in this country.

Locomotives in country districts having no smoke supervision show an average smoke density of 49 per cent. At Grafton the density of locomotive smoke during the first three months of observation by the Bureau of Mines equaled and often exceeded this figure. Individual engines under observation during this time showed smoke densities higher than had ever before been recorded in any smoke campaign in the United States. The fall of sooty solid matter recorded in the down-town section is as high as any on record.

The damage caused by this condition is difficult to figure in dollars and cents. It has been one of the main factors in holding back the growth of the city, and for this reason alone the loss to the community has been incalculable. The estimated per capita damage by smoke in American cities, due to the cost of the extra cleaning of rugs, carpets, curtains, household furniture, and interior and exterior decorations; laundry, and wear and tear on clothing, and the effect on stocks of goods in warehouses and stores, has ranged from $12 to $17 a year. In comparison with other localities where this per capita damage has been estimated, the first three months' observations at Grafton would indicate an estimate of $30 per capita as conservative. To this figure must be added the enormous but intangible loss to the community through the continual smokiness. Smoke from railroad activity of one form or another is responsible for practically 90 per cent of all the smoke in this territory.

That smoke conditions in the city could be greatly bettered was shown as a result of the campaign. In an effort to improve smoke conditions in Grafton the railroad and other interested parties were asked for co-operation. The railroad management responded in a highly gratifying manner, assisting in every possible way through various branches of the motive power division. In sixty days more than half of the smoke from locomotives was eliminated, and a very material reduction in smoke was made at the roundhouse and shops.

Experiments during the last 10 years have demonstrated that smoke from roundhouses can be reduced to a minimum by the judicious use of blowers and by the proper method of starting fires. Cleaning fires on the cinder pit is generally productive of much smoke. This smoke can be greatly reduced by igniting the fresh coal from the top, as in starting a new fire.

A large amount of smoke made in Grafton comes from engines held under steam in the yard. Smoke from this source can be controlled by careful firing and the proper use of the blower. Engines on the road can run without dense smoke if proper methods of firing are used. Road engines standing on track can be kept clean by the proper use of the blower, by judicious firing, and possibly by "cracking" the door. There is practically no excuse for black smoke from road engines standing on track. Standard equipment has been developed for locomotive operation which aids the fireman to keep down smoke while his engine is in the terminal. Firemen should realize that smokeless firing is both practical and economical.

Cost of Federal Control Shown in Final Report of Director General

Loss to Government During Period Exceeds $1,123,500,000—All Claims Settled Without Litigation

James C. Davis, Director General of Railroads, has submitted to the President his annual report for the year ended December 31, 1924, and, in addition, a final report as to the adjustment of the claims of all carriers whose property was taken over and actually operated by the Government during the twenty-six months of Federal control. Federal control commenced December 31, 1917, and ended February 29, 1920.

This adjustment represents a final settlement with every carrier whose property was actually taken over, except two small affiliated companies in Colorado.

The cost to the Government for the period of Federal control and the six months guaranty period immediately following it, the Director General reports to be as follows:

The loss of the Government during the period of Federal control aggregated .	$1,123,500,000
The expenses of the guaranty period are estimated by the Interstate Commerce Commission at	536,000,000
Amount required to reimburse small deficit roads (short lines), under the provisions of Section 204 of the Transportation Act, estimated by the Interstate Commerce Commission at	15,000,000
This makes a grand total of the loss and expenses of the Government during the 26 months of Federal control and the 6 months guaranty period of	$1,674,500,000

The following is the summary of Mr. Davis's report, as issued from his office:

This adjustment was one of the most important and perplexing problems requiring solution by the Government as a result of the World War. It is undoubtedly the largest liquidation involving a single commercial interest ever undertaken.

Property Worth $19,000,000,000 Taken Over

Including main line, passing tracks and terminals, there were 366,197 miles of road; 2,408,518 freight cars, 66,070 locomotives, and 55,939 passenger cars. The tentative value placed upon this property by the Interstate Commerce Commission, for rate making purposes, at the end of Federal control, was about $19,000,000,000.00.

For the year immediately preceding Federal control (1917) the gross earnings of the property were in excess of $4,000,000,000.00, and the net earnings in excess of $975,000,000.00. There were nearly 2,000,000 employes, and about the same number of bond and stockholders.

As a part of the property taken over, there was more than $530,000,000.00 of materials and supplies, distributed over the entire mileage, in warehouses, storerooms, shops, depots, and on line, and the Government took over cash working capital of the carriers aggregating $300,324,633.62.

The compensation or rent for which the Government was liable for the use of this property for the twenty-six months aggregated more than $2,000,000,000.00, or about $80,000,000.00 for each month of Federal control.

At the end of Federal control, after twenty-six months of Government operation, the separate transportation lines were returned to their respective owners with an obligation on the part of the Government to see that when returned reasonable compensation for the use of this property was made, and further, that the property was "in as good repair and as complete equipment as when taken over by the Government."

Government Owed the Roads $860,000,000

At the end of Federal control the Government owed the carriers a balance due on compensation for use of their property aggregating over $860,000,000.00

During Federal control the Government had advanced to the various carriers, for additions and betterments including allocated equipment, a total sum of $1,157,540,178.65. Of this total amount $380,036,122.94 represented the cost of 2,000 locomotives and 100,000 freight cars bought by the Director General during the period of Federal control and allocated to the various carriers.

Federal control ended February 29, 1920. In the latter part of that year the carriers began filing their claims against the Government for the balance claimed to be due them on account of the use and operation of their property during Federal control, and other claims based upon an undermaintenance of the property while the Government operated same. The principal items involved in the latter claims were maintenance of way and structures, maintenance of equipment, depreciation, replacements, and the like.

Claims Filed by Railroad and Government

The original claims filed by the carriers against the Railroad Administration growing out of Federal control, for the items above enumerated, totaled, $1,013,389,502.12. These claims were subsequently revised so that the amount of the claims actually the subject of liquidation, presented by the carriers, aggregated $768,003,274.23.

The Railroad Administration, on its part, set up tentative claims against the carriers aggregating a balance of $438,130,811.74.

These balances represented the disputed items respectively contended for by the carriers and the Railroad Administration. Included in the carriers' claims were items for undermaintenance of way and structures aggregating $341,825,409.62, and for undermaintenance of equipment $335,685,197.38.

In the Railroad Administration claims against the carriers there was a total claim for excess maintenance expenses, including both way and structures and equipment, of $309,614,100.24. These items of maintenance were the most important and the largest involved in the controversies arising in the liquidation.

The adjustment was completed without litigation. It was concluded in about four years, and it was made within the appropriations originally granted by Congress for that purpose.

The financial operations of the Railroad Administration disclose an unusual situation for a Government Bureau. The Railroad Administration, as a result of Federal control, took from the carriers definitive obligations consisting of funding notes, bonds, and equipment trust certificates, aggregating $629,202,550.00.

The Director General has collected or sold of these obligations, sales being made without recourse on the Government, a total of $454,513,750.00. This amount has been paid into the United States Treasury. Exclusive of some miscellaneous assets in the field, the Railroad Administration still holds definitive obligations of the carriers aggregating $174,688,800.00.

The present assets of the Railroad Administration, exclusive of some miscellaneous items, consist of:

Unexpended appropriations to its credit	$491,814,473.73
Definitive obligations of carriers	174,688,800.00
Total	$666,503,273.73

The obligations of the carriers held by the Railroad Administration all bear 6 per cent interest, and the annual interest on this indebtedness will more than provide funds to complete the remaining unadjusted items in this liquidation, so that the Railroad Administration is now and will be in the future an income producing asset of the Government rather than a liability, and the big question as to what the Government owed the railroads for the use of their property after the war is definitely ended and the debt paid.

Return to Railroad Capital Lower Per Unit of Service

The Increased Cost of Labor, Material and Taxes Absorb the Entire Revenue From Increased Rates

The most outstanding feature of the costs of producing and conducting railroad transportation during the last few years, according to Dr. M. O. Lorenz, Chief of the Bureau of Statistics of the Interstate Commerce Commission, is that the increase in the aggregate price to the public in rates is almost entirely explained by changes in operating expenses and taxes and not by any increased distribution to the owners of railway securities.

Dr. Lorenz has just made a full report to the Interstate Commerce Commission on the "unit costs of railroad service from 1915 to 1923." The purpose of the report, he explains, "is to show the average operating expenses, taxes, and contribution to the capitalist per unit of railroad service." Such a showing, he says, "is significant in the study of the causes for the increase in freight rates and passenger fares."

The increases in rates referred to, of course, are those which went into effect during the war and immediate post-war period, for all rate adjustments since that time have been downward.

In his report Dr. Lorenz stresses the following point in support of his conclusions. He says:

"In the so-called 'test period,' the three years ended June 30, 1917, the computed 'cost' per net freight ton-mile was 7.463 mills, which increased to 11.415 mills in 1923, an increase of 53.0 per cent.

"In the same period, operating expenses per ton-mile increased from 5.133 mills to 9.067 mills, or 76.6 per cent, taxes from 0.344 mills to 0.602 mills, or 75.0 per cent, and the contribution to the capitalist decreased from 1.986 mills to 1.746 mills, or a decrease of 12.1 per cent.

"This is upon a unit basis although in the aggregate, the capitalist's share increased from $892,000,000 in the test period to $962,000,000 in the year 1823, an increase of 8.8 per cent."

The increased return to capital in dollars to which Dr. Lorenz refers does not take into consideration the fact that the property investment in the railroads between the test period and the end of 1923 increased about 25 per cent. Nor does it take into consideration the decline in the purchasing power of the investor's dollar of income.

Dr. Lorenz explains in his report the difficulty of using any unit costs of operation which will satisfactorily represent the entire transportation service. He therefore uses four different units: costs per train-mile, per car-mile, per net freight ton-mile and per passenger-train car-mile. All of these show a decrease in the return to capital except the per train-mile figures, and they show a very slight increase.

The Railroads' Cost of Living Increased 89 Per Cent

"If the man-hour cost is assumed to have increased 119 per cent, and the material prices 74.5 per cent, . . . the weighted average increase in the railroads' cost of living would be 89 per cent for the calendar year 1923 as compared with the test period.

"That the total unit price per ton-mile paid by the public in 1923 increased so much less than the computed cost of living of the railroads is explained by the additional fact previously indicated that the capitalist's share does not reflect any increased cost of living."

Wages and Material Prices Have Increased the Most

In discussing the causes for the increase in operating expenses of the railroads, and the decrease of the capitalist's share in gross revenues, Dr. Lorenz says:

"Unquestionably the principal cause for the large increase in unit operating expenses as distinguished from the capitalist's share has been the increase in the prices of materials and wages of labor. This can be readily demonstrated even if it is not possible to measure with precision the effect of changes in prices and wages."

With regard to wages his report says:

"According to the annual reports of Class I roads, the average compensation to employes per hour in the year ended June 30, 1916, the middle year of the test period, was 27.6 cents. Based on the monthly reports of wage statistics, the average for 1923 was 62.6 cents. A special study made indicates that 119 may be taken as the per cent of increase in hourly wage costs from the test period to 1923.

"This does not represent the increase in the monthly earnings of employes, nor in the straight time rate, but is the increase in the average cost per hour to the railroad company both straight time and overtime."

With regard to the increase in the costs of materials and supplies, Dr. Lorenz's report says:

"A study made in this Bureau indicates that from the test period to 1923 the weighted average of prices for materials used by the Class I roads during the test period increased 74.5 per cent.

Snap Shots By the Wanderer

Some Sketches of a Real Mechanic

Many years ago there lived, in one of the mill towns of New England, a millwright who knew his trade as the common man knows his alphabet, and whose pride in his work equaled that of any monarch in the splendor of his court. And he trained his son in the ways he had himself traveled and taught him not only pride in his work but pride in the thoroughness with which it was executed. When this son grew to manhood he moved to a small town in central New York, and it was there that I knew him.

He had a little shop and was his own manager, foreman and workman, and it was in the capacity of the latter that I came to really know and admire him. He had been trained in a school where facilities were few and exigencies were many. He had been taught to use his wits and ingenuity in meeting the problems of the every day and had been drilled to be ignorant of the phrase: "It can't be done," regardless of the paucity of his resources and appliances. Hence the marvels of ingenious workmanship that were turned out of that little back yard shop.

Then somehow, by inheritance or training he was possessed of a most unerring mechanical judgment or instinct, or whatever it was, by which he could appraise the value of a new device; and many an one he has made to work by his skillful adjustment. Coupled to this was a sterling honesty that refused to take any man's money for the building of a machine that he did not think would work. There, then, was a man with whom it was a joy to deal.

I am not going to write his life but merely briefly sketch some of his achievements hoping that it may show to some ambitious apprentices what brains and skill can do in emergencies.

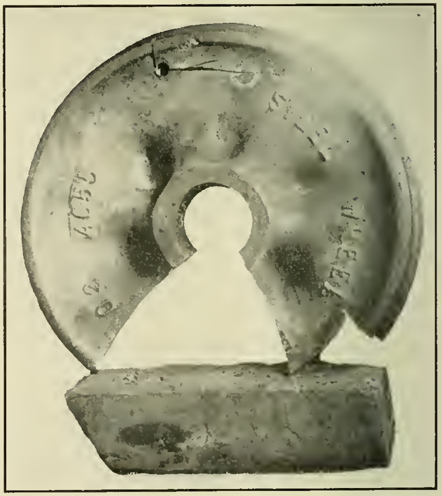
Did you ever try to cut a new steel tire in two? If you have you are well aware that there are internal compressive stresses of considerable magnitude, tending to push the particles of metal together and so pinch a cutting tool by which an attempt is made to sever it to such an extent that its movement becomes well nigh impossible.

There were a number of these tires to be cut, besides some steel and cast iron wheels. They were sent successively to two big establishments that were fully equipped with high powered Newton saws; and blithly they started to do the work, but the hard metal dulled the teeth and the internal stresses gripped the saw plates, and they soon gave it up.

Then, they were all sent to that little country job shop. The proprietor looked them over and decided that they could best be cut with a hack saw. So he bought a power hack saw for which he paid twenty dollars. He, too, soon learned of the gripping capacity of these tires, and after breaking about twenty saw blades in the first hour resorted to his wits.

By a clever change in the construction of the machine, he stopped the breakage and proceeded to cut those tires like so much cheese.

But the tires were not all. There were wheels also. The saw was a small one, it had a stroke of about 7 in. and



Steel Wheel Showing Cut Made with a Hack Saw

measured 6 in. from the teeth to the inside of the saw frame. Hardly adequate to cut a section out of a 33 in. wheel. So the wits were called upon again and the first victim was a steel wheel from which a section was cut as shown in the engraving. When this had been done it was found that the internal stresses existing in tires were as nothing to those found in the steel wheel.

It was then decided to cut a right angled kerf in the wheel on the side opposite to the removed sector.

A hole was drilled in the plate at A, and a kerf cut down in to it through the rim. The saw blade was then run at right angles to this radial kerf, cutting another for a distance of 9 in. out to X. This whole right angled kerf having been cut through the most obstreperous of metal without the breakage of a single blade.

The changes made in the machine were very simple but patentable, and the total cost of their application was about five dollars. It was suggested that the manufacturers might like to apply them to the little machine, and so the machinist offered to take out a patent and sell it to them. But they would not give it any consideration. An attitude that seemed strange in view of the performance that it had made possible. This was not all. It was desired to ascertain the tensile strength of the chill of a cast iron wheel. So the little hack saw was put to work to cut out a section of the rim, which was, in turn, sliced in a line with the circumference, in order to obtain a square section from which a standard test specimen ½ in. in diameter was obtained. All of which may be considered as a rather creditable output for a twenty dollar hack saw.

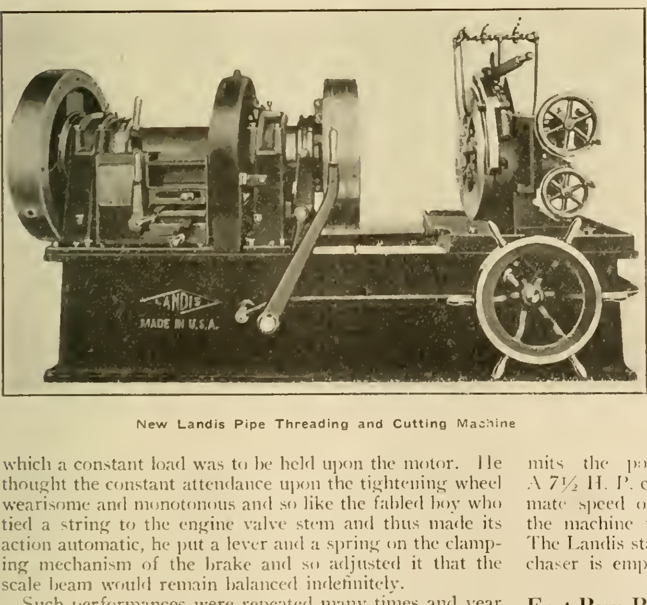
On another occasion he was given the job of turning a short section of a driver tire to a diameter of 78 in. and the privilege of doing the work on the wheel lathe in a nearby railroad shop was obtained. This would have been very well, but the lathe had a swing of but 72 in. So without reporting the fact he rigged an attachment to a small shaper, at a cost to his customer of two dollars and a half, gave the work a tilting motion and cut the surface to as true a curvature as could have been done on a lathe.

To be sure rocking the work in order to cut a curved surface with a straight running tool is an old trick. But to design and build the rigging and attach it to the tool at a cost of two dollars and a half, involved work that was both original and rapid.

Once he was called upon to make a prony brake test in which a constant load was to be held upon the motor. He thought the constant attendance upon the tightening wheel wearisome and monotonous and so like the fabled boy who tied a string to the engine valve stem and thus made its action automatic, he put a lever and a spring on the clamping mechanism of the brake and so adjusted it that the scale beam would remain balanced indefinitely.

Such performances were repeated many times and year after year throughout a long and useful life have a value as an example of what can be done in the way of making bricks with, at the most, very little straw.

Of course the man had brains, but he always attributed much of his success to his father's training in the art of meeting emergencies, a training that few boys now get in the modern shop where there is a special tool provided for every kind of a job that has to be done. A condition that is a great gain to the industry but a great handicap in the training of men.



New Landis Pipe Threading and Cutting Machine

New Landis Pipe Threading and Cutting Machine

The Landis Machine Company, Waynesboro, Pa., have added to their line of pipe threading and cutting machines a new 6 in. size. This machine has a range from 1 to 6 ins. inclusive. Two die heads are employed for covering this range; one 2 in. head for a range from 1 to 2 in. inclusive, and a 6 in. head for a range from 2½ to 6 in. The entire range of each head is covered by but one set of chasers.

The travel of carriage of this machine is 22 in. and it has 8 speeds. The speed of the driving pulley is 300 R.M.P., while the driving pulley is 14 in. in diameter and accommodates a 4½ in. wide belt. The machine is 9 ft. 8 in. in length and 4 ft. 9¾ in. in width. It weighs 8,800 pounds.

The illustration shows the operating side of the machine. It has a geared headstock and a single pulley drive.

The variations in speed, eight in number, are obtained by means of a self contained gear box, located beneath the main spindle. All gears steel, cut, and run in an oil bath. All bushings are bronze. The shaft bearings are lubricated automatically by a forced feed system. The main bearings are lubricated by flat link chains which run in oil contained in large reservoirs.

The front chuck has universal adjustment and is lever operated. This permits of gripping and releasing the pipe while the chuck is in motion. A universal geared chuck is employed at the rear of the machine and is fitted with flange grips for screwing flanges on and off. Both chucks have three jaws.

A reverse drive is obtained by a shifting lever for taking off or putting on flanges. This is an exclusive and distinctive feature of the Landis machine.

The cross rail supports the die head, and is also fitted with cutting off tools, reaming tool and length gauge.

The die lubricating system includes a rotary pump, a by-pass for the surplus oil and a special control valve at the head and cutting off tools.

All levers are located on the operating side of the machine in convenient reach for efficient and productive service.

This machine is very easily adapted to motor drive. The motor can be applied after the machine is in service. The motor is mounted on a plate over the gear box and a silent chain transmits the power from the motor to the machine. A 7½ H. P. constant speed motor, wound for an approximate speed of 1200 R.M.P. is required. This enables the machine to be operated at its maximum efficiency. The Landis stationary die head and the long life tangential chaser is employed.

Fast Run Between New York and Philadelphia

A new speed record for fast passenger train movement between New York and Philadelphia was made last month when a special train of three cars made the run of 92.6 miles on the Pennsylvania Railroad in 90 minutes flat. The train carried the famous Jewish tenor, Cantor Rosenblatt, to keep a New York singing engagement.

Electrification—A Factor in the Development of the Railroad Industry*

By A. J. MANSON, Manager

Heavy Traction Division, Railway Department Westinghouse Electric & Manufacturing Co.

With the increase in population, the growth of manufacturing plants and industries, and the increase in volume of agricultural products, as well as the rapid increase in the size of our cities, the railroad will be confronted with the lack of track capacity and terminal facilities to meet the increasing rate of tonnage that is inevitable. In fact, at the present time, the demands for freight movement in many sections of the United States has called for service far in excess of present possibilities, and the railroads are confronted with the necessity of increasing their facilities at these points. To economically handle this growing traffic, larger trains must be handled at higher speeds.

During the past few years, major improvements on our railroads have been curtailed, due to overburdensome regulation and restraint. To eliminate the congestion already here, and to increase the capacity for present demands, and also to provide for future requirements, major improvements are essential if our railroads are to effectively handle the demands imposed upon them. One of these major improvements is undoubtedly electrification.

Growth of Electric Traction

It should be remembered that electric traction became a commercial factor only a decade or two ago. Developments were rapid. It was soon recognized that the shunt motor was not adapted for railway work, so the series motor was used because of its characteristics of heavy starting torque and its ability to adjust itself readily to the varying tractive effort required to start a train, and to propel it over different grades and curvatures.

The introduction of the carbon brush, replacing the copper one, and the use of commutating poles or interpoles, has practically eliminated the question of commutation, and has made possible the design of motor units of over 1,000 horsepower.

The control apparatus has gone through a similar development. The early control consisted of hardly more than a switch for opening and closing the small current, or a simple drum type controller. With the growth of the elevated systems, then operated by steam engines, the great possibility of operating these trains in multiple by electricity was recognized and the multiple unit control was initiated, utilizing the remote control of switches. This idea has developed and has been applied to the electric locomotive, so that today we have unit switches, remote controlled from a master controller at the head end, as well as the operation in multiple of large motive power units, these switches suitable for handling currents as high as 3,000 amperes.

Other apparatus going to make up the complete locomotive has kept pace with this development of the motors and the control so that we have in the locomotive today a most reliable piece of machinery.

Operating Characteristics of the Electric Locomotive

Electrification means the use of the electric locomotive in place of the steam locomotive; so it may be of interest to see just how these two types of motive power units compare.

The main and important fact which should be kept in mind when comparing these two types is this—The steam locomotive must develop its own power, whereas the electric locomotive is merely a converter of power.

The tractive effort of the steam engine depends on the mechanical dimensions of the cylinder bore and stroke, the driving wheel diameter, and the boiler pressure. All of these items are fixed with the exception of the boiler pressure. Even this item is fixed in that a maximum pressure only is available, and with this full boiler pressure the engine will deliver its maximum tractive effort.

The tractve effort of the electric locomotive, on the other hand, does not depend on fixed mechanical dimensions, but on the electrical characteristics of the motors, the only fixed mechanical dimension being the drivers. The electric locomotive is not a self-contained unit as is the steam locomotive. Each motor develops a certain turning moment or torque, depending on the amount of current passed through the motor, which, by mechanical connections, is transferred to the drivers as tractive effort. Knowing the electrical characteristics of each motor, the total power for the locomotive is a multiple of the number of motors utilized. Curves, therefore, can be supplied showing the performance of the complete locomotive so that it is possible to read directly the total current taken by the locomotive, the tractive effort in pounds which the locomotive will develop at this current, and also the corresponding speed and miles per hour for this tractive effort.

The electric locomotive tractive effort cannot be compared strictly to the resulting tractive effort, due to the steam action in the cylinders of the steam engine. The one is dependent on the amount of current passed through the motor winding, which, within limits, can be as large as desired, while the other depends on a maximum steam pressure, and a limited boiler capacity. The maximum tractive effort in the case of the electric locomotive is, therefore, not fixed, as is the case of the steam locomotive. This fact makes it possible to take advantage of the extra adhesion which may be natural or secured by the application of sand.

One important point must be realized, and that is that while the electric locomotive can exert this high maximum tractive effort, this cannot be maintained continuously because the excessive heat which would result from the high currents passing through the motor windings would cause serious damage to the windings. There is a current, however, which can be taken continuously.

This leads us to the discussion of the continuous and hourly rating of the electric locomotive; ratings which do not apply to the steam locomotive, and which are a decided factor in getting trains over the road.

Every engine division has certain fixed conditions as regards grades and curves. Loads assigned to the steam engine must not, of course, be in excess of a certain maximum value, allowing certain percentage excess of tractive effort for possible starting under the maximum compensated grade. The locomotive must be rated in terms of its maximum load in tons that it is safe to haul for the division or divisions over which it operates. During the winter months, this maximum tonnage must be decreased

*A paper read before the Canadian Railway Club.

and corrected for temperature. This rating of the steam locomotive is known as the "equated tonnage" rating system.

The "equated tonnage" rating corresponds, as nearly as the two entirely different machines can be compared, to the continuous rating of the electric locomotive. The continuous rating of the electric locomotive is fixed, but it is determined in an entirely different way from the "equated tonnage" rating of the steam locomotive. The continuous rating of the electric locomotive does not mean the maximum load which the locomotive will take over the road. It will pull a heavier train and maintain the schedule, but the feat will be accomplished at the expense of overheating the motors. The electric locomotive, being a converter of power and not a generator of power, will not reach a maximum capacity and stop, but can be overloaded as any electrical motor. Whether or not this overloading will damage the equipment depends on the time the overload is maintained. So, in addition to the continuous rating, we give the locomotive a one-hour rating, which naturally is much higher than the continuous rating.

The hourly rating, not existing with the steam engine, represents the tractive effort which could be maintained for one hour, starting with the motors cool,, without overheating them. As would be expected a large number of ratings could be given the electric locomotive, depending on the time interval, as larger currents can be taken for shorter periods of time.

I believe it is now clear why it is possible with an electric locomotive to get high tractive effort for starting or emergency conditions, and why this tractive effort cannot be maintained continuously. In applying load to the electric locomotive, a maximum grade on the division may not govern the tonnage, as high tractive effort can be excited for short periods, but the entire profile must be considered and the load regulated so that the average current required does not exceed that for its continuous rating. This factor makes it possible to give an electric locomotive a tonnage rating higher, in proportion to its weight on drivers, than would be possible for a steam locomotive operating over the same profile.

Another very important point which should be appreciated when comparing steam and electric locomotives is the horsepower rating. Horsepower is the product of tractive effort and speed, and being the direct measure of the locomotive's capacity to do work, it is a measure of the hourly ton miles that can be handled; the all important factor in railroading. While the operating man is interested in an engine's ability to handle trailing load, the speed at which a certain load can be handled is of the utmost concern. Electric locomotives excel steam locomotives in this respect. The maximum tractive effort of an electric locomotive can be maintained up to speeds two to three times that at which the steam locomotive can maintain its maximum tractive effort, due again to the fundamental condition that the maximum power possible of development by the steam locomotive is a fixed quantity, whereas with the electric machine, the maximum power is limited only by the heating effect in the motors.

With the widely different characteristics of the two machines, and the substitution of the electric motors for the boiler and cylinders, the electric locomotive is hardly limited as to its capacity in tractive effort and speed. It is possible to combine motive power units singly controlled, and haul more tons over a great distance in less time than it is possible to do with a steam locomotive. In addition, the electric locomotive has a very high serviceability factor which experience has shown is equal to nearly 90 per cent.

On the other hand, great strides have been made in the design of the steam locomotive. Today a typical freight locomotive is approximately 90 per cent heavier than a corresponding unit built 20 years ago, and this same engine develops approximately 3⅓ times the indicated horsepower of the latter. Weight per indicated horsepower has, in other words, been reduced approximately 43 per cent. Steam passenger locomotives have also developed with equal efficiency. Progress has still further been made in the design and construction of the three-cylinder locomotive, and the utilization of high and low pressure cylinders. Undoubtedly this development in efficiency of the steam locomotive has been hastened by the results of operation and efficient performance of the electric locomotive.

It is more essential than ever, in view of this development, that a very careful analysis be made of all factors pertaining to operation. Every railway should have a constant and accurate knowledge of the economic value of its motive power, and, in order to obtain a sound acceleration of motive power as an investment, should have reliable knowledge of the latest developments in the art of locomotive construction and operation, both steam and electric.

This study will point out that the electric locomotive has two major items of savings over the steam; namely, crew expense and decrease in maintenance charges. More work can be accomplished in the same time with the electric locomotive and the greater availability for service which the electric has over the steam means a decrease in maintenance expense.

While the developments on the steam locomotive, to economize in the use of steam, have greatly increased their efficiency by saving in fuel, and have increased their hauling capacity, the addition of these refinements hardly tend to reduce the maintenance or increase the availability for service. On the other hand, the electric locomotive is a comparatively simple piece of machinery with developments constantly tending to simplify the design and improve the operation rather than to complicate them. The availability for service is an important item, and while the best steam locomotive is a very efficient machine, the total cost of operation of a division of a railroad is after all the final answer, and the one which must be considered in the analysis. The management is interested in the type of system; that is, steam or electric, which will not only show the maximum net earning capacity, but which is suitable for the future service conditions, and the one which is going to get the most out of the railroad's right-of-way.

To sum up briefly the advantages enjoyed by the electric locomotives are:

(1) High tractive efforts for short periods can be obtained to meet starting, heavy grade or emergency conditions.

(2) The tonnage load which can be taken over a division is not necessarily limited by the maximum grade and temperate conditions but by the profile as a whole.

(3) The ability to maintain the maximum tractive effort up to speeds two or three times that at which the steam locomotive can maintain its maximum tractive effort means an increase in hourly ton miles handled over a division.

(4) The possible operation of motive power units in multiple.

(5) A very high serviceability factor.

Electrification—A Problem of Distribution

Advance in the art is now such that electrification need not be postponed on account of the question as to what system is to be employed, and for the fear that the wrong one may be chosen. Each system has been developed to a high degree of service and reliability, and each has its own most efficient application, and when properly applied each will show economic results.

The most careful consideration, however, must be given to all problems involved before choosing the system, and the most serious consideration and study should be given to the future conditions rather than to the present facts. Electrification, in the broad sense, may involve not only operation of through trains and freight trains, by electric locomotives, but for suburban commuter service the use also of multiple unit trains. This consideration may have a great weight on the system to be employed. At present, the experience we have gained with 1200 to 1500 volts per motor on multiple unit equipment is insignificant. There is a material difference between the electric locomotive and multiple unit service in one very important respect; namely, that in the electric locomotive the apparatus and equipment is accessible to the operator, while in the multiple unit equipment, it is remote from and inaccessible to the operator. This is a condition which, with high voltage, does not lend itself to the most successful operation.

As mentioned in the earlier part of this paper, our traffic demands are increasing and in the future the demand for service will be more strained than it is today. We are operating heavier trains and electrification is going to amplify and increase train weights rather than lessen them, and these rates will be combined with higher speeds. To meet this increased service will mean greatly increased power requirements over that realized today. The electrified system to be installed must lend itself to future expansion and not be one that will handle the present day requirements alone. Otherwise, the real value of electrification to the American railroads will be limited.

One of the difficult problems in railway operation is to economically and effectively handle extreme fluctuations of loads over any section of the railroad. This congestion of traffic at certain points may be a frequent condition, and is met by a concentration of locomotives. An adequate electrification must be able to cope with this concentration of locomotive power at any section. To meet this intensified operation, the distribution system used must be capable of delivering heavy drafts of power at remote distances from the source of generation. The system must be one that can economically handle the maximum transportation requirements that it is desirable to impose upon it.

These ever increasing demands of power from the power companies, and the demands of concentrated loads at remote distances, have meant that the transmission of the power is a most important and a controlling factor. Originally, the power distribution was direct current, but with the introduction of the transformer into America by George Westinghouse, the development of the alternating current system was inaugurated, and at present is used almost universally. Expansion of the power companies has been due briefly to the transmitting of the power at higher and higher voltages with smaller and smaller current required for the same horsepower of energy transmitted.

So it can be with the electrification of railroads. I can visualize enormous drafts of power that will be required to handle 7,000 to 8,000 ton trains on heavy grades at speeds of 20 miles per hour. And these heavy power demands reflect back to a transmission problem, and this transmission following the present rapid growth will be a transmission of high voltage alternating current with single phase on the overhead railway because of simplicity. The locomotives may be anything best fitted to the conditions to be met; the single phase locomotive equipped with single phase motors, as are the latest 180-ton A-C. D-C. electric passenger locomotives operating on the New Haven Railroad; the split phase locomotive, equipped with a three phase motor, as the locomotives in operation on the Norfolk & Western Railway, handling the heavy tonnage coal trains over the Elkhorn grade; the motor generator locomotive, equipped with a motor generator set and obtaining its tractive effort from direct current motors, as the Ford locomotive.

Utilizing the transformer, the locomotive can have the auxiliary apparatus, the motors and the control equipment at low voltage, a condition so important to the multiple unit part of any electrification. It is thus that the alternating current locomotive and car equipment is entirely independent of the trolley voltage, which lends itself to a much wider field for design.

The present installations in operation, using single phase alternating current, have utilized 11,000 volts on the overhead wire. There is no particular reason for stopping at this voltage. As demands are made for heavier drafts of power, this voltage can be raised. In fact, the Virginian equipment is laid out for operation with 22,000 volts on the trolley, as is also the Ford motor generator locomotive.

A Possible Solution of the Financial Problem

I believe it is safe to say that with the rapid strides made in every industry, there is in the minds of our railroad executives no question as to the desirability of railroad electrification. The important question to these executives is how to raise the necessary capital to make the improvements and thereby benefit by the expenditure. While this fact has been a real problem in the past, it is nearing a solution, and this solution can be credited to the large power companies.

With the ever increasing interest in the super power idea; that is, the tieing in of the power companies into a network of transmission system, and the development of large power plants at water power cities, or at the mines, the power companies are ready to equip themselves to supply power to the railroads and deliver this power to the overhead transmission system. These power companies are now in a position to supply adequate and reliable power at all times, and considering this railroad load in connection with their other industrial and lighting loads, should be in a position to generate and supply this power at the minimum price for any particular district.

The power plant and substations of any electrification represent a large capital investment and a large part of the total electrification costs. With the power companies developed to furnish to the trolley wire the energy required, and owning and controlling the transmission lines and substations, which may profitably to both parties be on the railroad's right-of-way, they can utilize these lines to develop manufacturing industries along the route, and thereby under these conditions make a very reasonable price to the railroad company for power.

Date of Air Brake Convention Is Changed

In order to permit members of the Air Brake Appliance Association to avail themselves of summer railroad rates to the Pacific Coast, which become operative May 15, the Executive Committee of the Air Brake Association has changed the date for their annual convention which was to be May 5-8 to May 26-29. The meeting will be held at Los Angeles, Calif. Mr. J. Sinkler, Peoples Gas Building, Chicago, Ill., is Secretary of the Air Brake Appliance Association and applications for membership and exhibit space should be made to him.

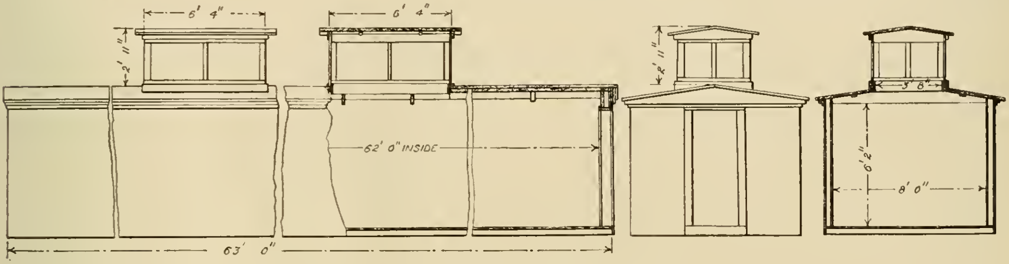
Shop Kinks

Some Labor and Expense-Saving Devices Used Upon the Erie Railroad

Tool House.

The retired freight car that has lived its life of usefulness and is no longer safe for transportation purposes appears in many places as a shelter for all sorts and conditions of stationary services. Set low upon the ground with a four-pane window to admit light and air it is usually cheerless and shabby; and because it is both of these it is quite as usually unkempt and dirty.

It is no new trick to use an old freight car for a tool house, but it is an unusual trick to spend a few dollars in cutting a hole in the roof and building a monitor over it. It is astonishing the difference this makes in the internal appearance of an old derelict. It has the same effect that the deck had in adding to the attractiveness of the passenger car as compared with the old and original low-roofed construction.



A Locomotive Tool House

The illustration shows two such cars placed end to end, with a door cut in one end. The effect is that of a long, cheerful, well lighted corridor.

Such an arrangement has the advantage of long unbroken wall spaces for shelving with their whole length illuminated from above, with good ventilation and plenty of air space and head room.

The monitors as so made are only 2 ft. 11 in. high, 6 ft. 4 in. long and 3 ft. 8 in. wide. Little enough of expense to obtain a tool house 62 ft. long and 8 ft. wide on the inside, and one in which it is a pleasure to work.

Tube Swedging Machine

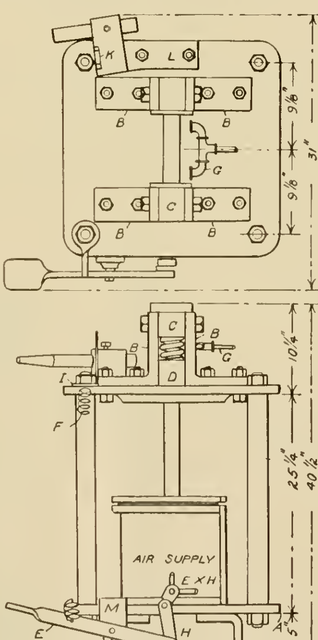
The attention of the readers of these Kinks has been frequently called to the great variety of uses to which discarded air brake apparatus, and especially the cylinders, are put. Well, here is another, in which an old 12 in. by 10 in. brake cylinder is made to do duty as the motive power of a simple homemade swedging machine for tube work. Added to this there are a couple of old steam chest covers for the top and bottom plates and the greater part of the material, insofar as weight is concerned, is provided from scrap.

The lower plate, A, is drilled to match the holes in the flange of the cylinder, and near the corners there are four holes to take the holding bolts. The two plates are held apart by four pieces of 1½ in. pipe each 24 in. long, through which as many 1⅛ in. bolts are passed. These are threaded at each end, and with the separators and the two steam chest covers form the base of the machine.

The cylinder is bolted to the lower plate and instead of a single piston rod, there are two rods set 8½ in. apart from center to center on the piston and passing up through the holes cut in the head as indicated on the detail drawing. The use of two rods pushing against the moving crosshead at each end prevents the latter from canting or tilting under the eccentric loading to which it is subjected in service.

To the top of the upper plate four guides *B* are bolted. These are simply angles made of 3½ in. by 1 in. steel, and between the upper ends of their vertical legs the upper crosshead *C* is bolted. The bottom crosshead *D* is of the same shape as top one, as shown in the engraving, except that the rib *X* is on the bottom and the fastening holes *Y* are omitted.

The swedge blocks, whose thickness is governed by that of the tubesheet, and which are not shown in the elevation and plan of the machine, are bolted to the side of the body of the crossheads by ⅝ in. bolts through the holes *A*.

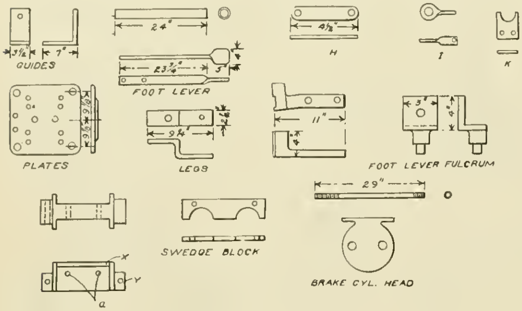


General Design of a Swedging Machine

The piston rods which are 1½ in. in diameter have a bearing against the bottom of the lower crosshead and, when a pressure is admitted to the cylinder below the piston, they force the crosshead up and the swedge blocks squeeze the tube which has been put in place.

The return stroke is effected by a steel spring, made of ¼ in. diameter steel, which is placed between the squared ends of the two crossheads as shown in the elevation of the machine.

The machine is operated by compressed air, which is admitted to the lower end of the cylinder by means of a three-way cock, which is operated by a foot lever *E*, which is held in its upper or release position by a long steel spring F reaching from the lever to the upper plate as shown in the elevation. This spring is made of 3/16 in. diameter steel and is fastened at its upper end to a clip *I*, ¼ in.



Swedging Machine Details

thick which sets down over one of the corner bolts and is held by the nut on the same.

When the lever is released and the three-way cock turned to the exhaust position, the escaping air flows out through the two exhaust openings *G*, shown in the plan, and blows away any scale that may have been loosened and dropped upon the crosshead or upper plate.

The foot lever is pivoted on a fulcrum *M* which has a teat turned to fit in a hole in the lower plate where it is held in place by a cotter passing through its lower extremity.

Pneumatic Holder

This holder for driving rivets is made in two sizes. In the short size the length of the cylinder *C* between shoulders is 6⅜ in., and, for the long size it is 11¼ in. With the plunger retracted the length overall of the short size is 10⅜ in. and of the long size 15¼ in.

The cylinder *C* is made of hydraulic 4 in. outside diameter pipe, which is turned to a diameter of 3 7/16 in. and bored to an inside diameter of 2 15/16 in. A shoulder and larger diameter at one end is cut with a taper thread of 12 to the inch to take bottom *D* and holding bar. This bottom has a socket 2 1/16 in. in diameter and 1¾ in. deep to receive a 2 in. diameter rough bar for manipulating the holder.

When the bottom has been screwed in place, a hole *E* is drilled and tapped through it and the cylinder, flush with the end of the latter, and into this the connecting pipe of the valve is screwed.

The piston *F* has a length over all of 8 in.; it is made of a solid steel bar and is bored out at the holding end with a tapered socket to fit over the head of the rivet. At that end it has a diameter of 2¼ in.

At the piston end is 2 59/64 in. in diameter for a distance of 1 in. and is cut with a packing groove ¼ in. wide having a diameter of 2½ in. Packing is effected by a leather packing ring held out against the wall of the cylinder by a 1/32 in. by 3/16 in. steel spring.

The piston is prevented from bottoming in the cylinder by the head of a tap bolt *G*, which is screwed into the packing end of the cylinder.

The piston head *H* is threaded to mesh with the internal screw cut in the cylinder and is bored 1/64 in. larger in diameter than the stem of the plunger to permit the free movement of the latter.

The holder is operated by compressed air which is admitted and released by a two-way valve having a side opening *I* in the shell for the exhaust.

The advantage of such a holder is its lightness and easy portability.

Tool For Grinding Steam Pipe Packing Rings

The old method of grinding the packing rings for steam pipes in place by hand was expensive in that it was a slow piece of hand work and tiresome because of the difficulty of holding the ring.

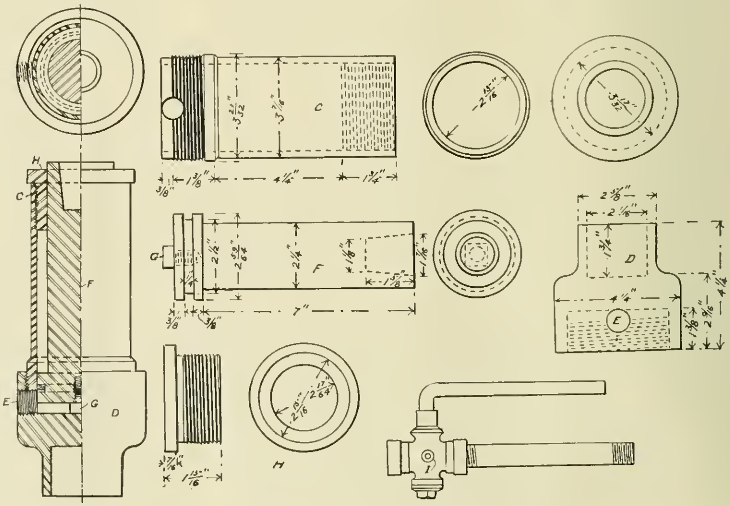
The arrangement shown here was designed at the Meadville, Penna. shops and utilizes an air motor directly attached or a length of flexible shafting driven by any suitable motor as the driving mechanism.

It is formed of the central shaft *A* having one end in the form of a No. 3 standard Morse taper, and the other turned to a diameter of ⅞ in. and cut with a screw of 12 threads to the inch, except for a plain cylindrical portion about 1¼ in. long between the thread and the taper shank on which a three-armed yoke *B* is set and pinned.

The arms of this yoke are drilled for a ⅜ in. diameter pin, by which the swinging arms *C* are attached to it.

Two nuts drilled for a spanner wrench and with the outside face knurled for rapid turning by hand are screwed upon the threaded portion of the shaft and between them the yoke *D* is slipped on over the thread. By means of the nuts this yoke can be fastened in any desired position.

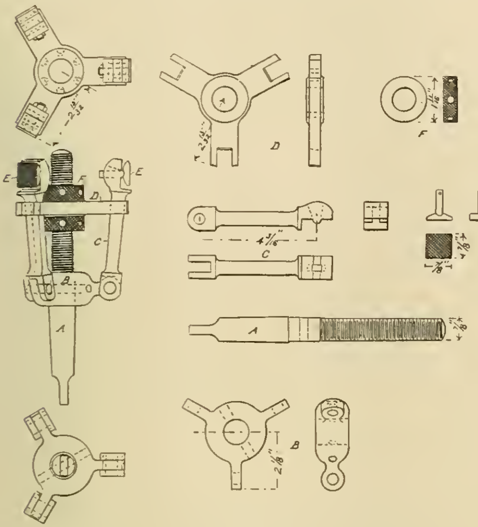
The swinging arms *C* are made at one end with a holder arrangement, and a tapered slot cut through it. This slot is ¼ in. wide and tapers from a width of ¼ in. at the face to 9/16 in. at the back. The face is ⅞ in. wide and running from the edge of the slot to that of the face on each side is a semi-circular lug of ¼ in. diameter.



Details of Pneumatic Holder

A shoe E ⅞ in. square on the face, which is serrated and fitted with a groove to receive the lug on the end of the swinging arm, and with a stem of ¼ in. diameter to slip into the slot, is set against the holder.

It is evident that the shoe has freedom to oscillate to a limited extent about the semi-circular lug, but is otherwise held square with the holder.



Device for Grinding Steam Pipe Packing Rings

With these in place the shoes are set inside the ring to be ground and the outer nut F is run up on the thread. As the swinging arms rest in the slots cut in the yoke D and as the latter is pushed towards the yoke B by the nut, the arms are caused to swing outward, carrying the shoes with them and into contact with the inner surface of the packing ring. Then, by tightening the nut F the shoes can be made to grip the ring securely. This done the other nut is used as a check nut to avoid any possibility of slipping.

The ring can then be brought against its work and revolved until it has been ground into place, and at the same time it can be lifted out and the condition of the two surfaces determined with the same ease as when the work is done by the slower hand method.

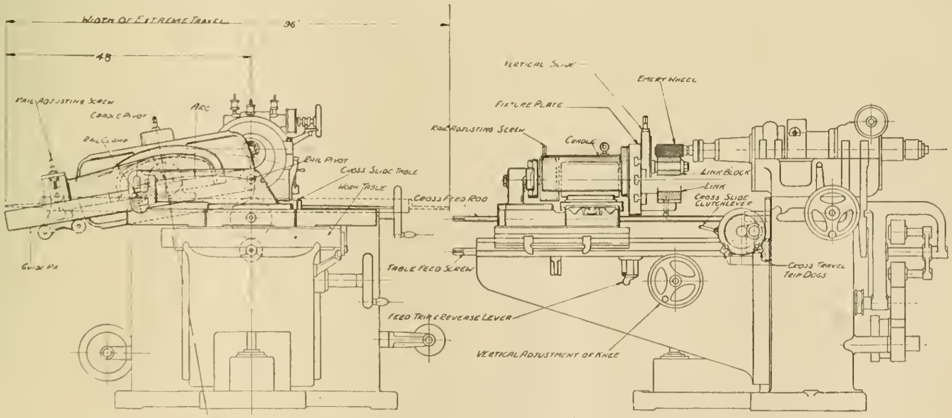
New Internal Link Grinder

The internal grinder, made by the Gisholt Machine Company, Madison, Wis., for grinding holes in locomotive motion work, air pump cylinders and similar parts has been equipped with an attachment for grinding links and link blocks. This attachment greatly increases the field of usefulness of the machine so that, besides being suited to use in large railroad shops, it can be installed with profit in comparatively small shops and engine houses which may not have enough internal grinding and radius grinding work to justify the purchase of two separate machines.

The cross sliding head of the new Gisholt grinder and the generous travel of the knee give a wide range of adjustment. The table travels back and forth for grinding length and the headstock crosswise for central and center to center adjustment. This adjustment reduces the overhang of the work to a minimum, an important feature when grinding the low pressure cylinders of cross compound air pumps, for example. The machine has a capacity to grind 2¾ in. to 4½ in. holes, 13 in. deep and 4½ in. to 8 in. holes, 16 in. deep. By means of special spindles furnished as extra equipment, 1 in. holes can be ground to 5 in. depth; also 8 in. to 14 in. holes up to 16 in. deep.

The link or arc grinding attachment is mounted on the work table and consists of a cross slide table in the center of which is located a pivot, carrying a cradle free to rock on the pivot. A rail pivoted in the same horizontal plane as the pivot for the cradle and having an angular adjustment in the vertical plane controls the rocking motion of the cradle as the cross slide travels back and forth.

The grinding wheel spindle, located in the same vertical plane as the rail pivot, remains stationary so that the combined movement of the cross slide and the cradle will produce a circular arc tangent to the grinding wheel. The center of this arc is located on a line perpendicular to the cradle and through the center of its pivot.



Gisholt New Internal Link Grinder

The angular adjustment of the rail for the desired radius is obtained from a chart mounted on the attachment.

The cross slide table is driven by power from the regular table feed screw provided with a clutch for disconnecting the work table power feed. The power movement of the work table and the cross slide therefore cannot take place simultaneously, but hand feed is always available for the work table, so that occasionally it can be moved back and forth to insure even wear of the wheel and a parallel surface.

The feed trip and reverse lever controls the reverse motion of the cross slide table through the regular table trip mechanism which also can be operated by adjustable trip dogs on the trip disc when automatic reverse is required.

When grinding internal arcs, such as locomotive links, the work is secured to the fixture plate by means of suitable clamps, but when grinding external arcs, such as link blocks, the work should be held preferably on a vertical slide attached to the fixture plate providing greater adjustment than can be obtained with the knee of the machine.

The work should always be located so that the center of the arc to be ground falls in the vertical plane passing through the center of the wheel spindle, the axis of the rail pivot, and the axis of the cradle pivot,—all of which must be in line whenever the work is set up. The chart gives the set-up angle for selected arcs passing through the rail pivot; that is, the mean arc when referring to locomotive links and link blocks. To bring the abrasive wheel in contact with the surface of the arc, the knee is raised or lowered as the case requires.

If the guide rail is set parallel to the movement of the cross-slide, the radius of the arc will be of infinite length. The machine, therefore, can be used for straight surface grinding without removing any part of the attachment. It desired to grind straight surfaces on work which cannot be held conveniently on the fixture plate, the cradle can be removed easily and the work placed on the horizontal cross slide table.

The length of the cross slide table is 34 in. and the width 7½ in. The length and width of the fixture plate are 26 in. and 10½ in. respectively. The table has 30 in. cross movement. The surface speed of the table is 2.5 and 4.8 ft. per min. A 2¼ in. to 2½ in. wheel is used with a ¾ in. hole and 3 in. to 4 in. face. The Link Grinding Attachment weighs approximately 500 lbs.; the total weight of the machine is 3,100 lbs. A 5-hp. motor running at 1,800 r.p.m. is recommended to drive it.

Woodlock Named to Succeed Commissioner Potter

Thomas F. Woodlock of New York, a financial writer, has been nominated by President Coolidge to succeed Mark W. Potter, also of New York, as a member of the Interstate Commerce Commission. Mr. Potter has resigned.

Mr. Woodlock was born in 1866 in Dublin, Ireland. He was educated in Ireland and in England, where he attended Beaumont College and London University. He entered business in London in 1889, and in 1890 and until 1892 he was in newspaper work, connected with the London edition of the New York "Herald," "Vanity Fair" and the "Bullionist."

He came to New York in 1892 and went to the "Wall Street Journal," where he worked as editor and wrote on money and foreign exchange and also on the railroads. He was part owner of the publication from 1896 until he retired in 1905.

He became associated with the Stock Exchange firm of S. N. Warren & Co. upon leaving the "Wall Street Journal," and was a member of the Exchange from 1906 to 1918.

In 1918 he became secretary of the American International Corporation and held this post until 1923. At present he is a director of the Pere Marquette and of the St. Louis & San Francisco roads.

Aitchison Elected Chairman of I. C. C.

Clyde B. Aitchison, of Oregon, has been elected chairman of the Interstate Commerce Commission for the year 1925, in accordance with the commission's usual practice of rotating the office of chairman among its members in order of seniority.

Mr. Aitchison was originally appointed a member of the commission by President Wilson in 1917 and was chairman during the year 1919. He was born on February 22, 1875, at Clinton, Ia. He practiced law at Council Bluffs, Ia., from 1896 to 1903 and at Portland, Ore., from 1903 to 1907. He was clerk of the state tax commission of Oregon from June, 1905, to July 1, 1906, and was one of the authors of the Oregon Railroad Commission law, adopted February 18, 1907.

He was appointed a member of the Railroad Commission of Oregon for a short term, was elected a member in June, 1908, was elected chairman in January, 1911, and reelected on November 5, 1912. In 1916 he resigned to become solicitor for the valuation committee of the National Association of Railway Commissioners, with offices at Washington.

He took an active part in representing the interests of the state commissions in connection with the valuation of railroads being made by the Interstate Commerce Commission. His first appointment to the commission was for a term ending in 1921 as one of the two additional commissioners authorized by the law of August 9, 1917, and he was reappointed by President Harding for a term ending December 31, 1928.

Notes on Domestic Railroads

Locomotives

The Grand Trunk Western Railroad has placed an order for 8 Mountain type passenger locomotives with the Baldwin Locomotive Works.

The Nashville, Chattanooga & St. Louis Railway has ordered 5 Mountain type locomotives from the Baldwin Locomotive Works.

The Rutland Railroad is inquiring for 3 Pacific type locomotives.

The Andes Copper Mining Company has ordered 3 Mikado type locomotives from the Baldwin Locomotive Works.

The Missouri-Kansas-Texas Railway is inquiring for 14 locomotives.

The Chesapeake & Ohio Railway has placed orders covering 48 locomotive boilers and fireboxes with the American Locomotive Company. The work is to be done at the Richmond plant, at Richmond, Va.

The Belt Railway of Chicago has ordered 5 switching type locomotives from the Baldwin Locomotive Works.

The Chicago, Rock Island & Pacific Railway is inquiring for 10 switching locomotives of the 0-8-0 type.

The Louisville and Nashville Railroad has placed an order for 16 Mikado type locomotives with the American Locomotive Company.

The Pitthurgh & Lake Erie Railroad has ordered 10 locomotive tenders from the Lima Locomotive Works.

The Pacific Electric Railway has placed orders with its shops at Terrance, Calif., covering the construction of 5-60 ton freight locomotives.

The Atlanta & West Point Railroad has ordered 2 Mikado type locomotives from the Lima Locomotive Works.

The Michigan Limestone & Chemical Company has ordered 6 heavy six-wheel type locomotives from the Lima Locomotive Works.

The Cuba Railroad has placed an order for 6 Mikado type locomotives with the American Locomotive Company.

The Chicago & Western Indiana Railway has placed an order for 5 eight-wheel switching locomotives with the Baldwin Locomotive Works.

The Union Pacific Railroad has placed an order for one locomotive with the American Locomotive Company.

The Oahu Railway and Land Co., Hawaii, has ordered 2 Mikado type locomotives from the American Locomotive Company.

The Anderson Middletown Lumber Company has ordered one Prairie type locomotive from the Baldwin Locomotive Works.

The Oeste de Minas E. de F., Brazil, has ordered one Pacific type three cylinder locomotive from the Baldwin Locomotive Works.

The Georgia & Florida Railway plans to enter the market shortly for 2 locomotives.

The Cornwall Railroad is inquiring for one consolidation type locomotive.

The Canadian National Railways is inquiring for 4 Mountain type locomotives for use on the Grank Trunk Western Railway.

W. R. Grace & Company, New York city, is inquiring for one 0-4-0 type locomotive for export.

The Arrangua, Cia Santa Catharina Carbonifera de Brazil has ordered 3 Pacific type locomotives from the Baldwin Locomotive Works.

The Texas City Terminal has ordered one 0-6-0 type switching locomotive from the Baldwin Locomotive Works.

The Chicago, West Pullman & Southern Railroad has ordered one 0-6-0 type switching locomotive from the Baldwin Locomotive Works.

The St. Louis-San Francisco Railway is inquiring for 25 Mikado type and 5 Mountain type locomotives.

The International Railways of Central America have ordered 12 consolidation type locomotives from the Baldwin Locomotive Works for export to Guatemala and Salvador.

The Commonwealth Steel Company, St. Louis, Mo., has ordered one 0-6-0 switching type locomotive from the Baldwin Locomotive Works.

Freight Cars

The Palace Poultry Car Company has ordered 50 poultry cars from the Illinois Car & Manufacturing Co.

The Chicago, Rock Island & Pacific Railway is inquiring for 1,200 box cars of 40 tons' and 400 gondola cars of 50 tons' capacity.

The Morrell Refrigerator Line has ordered 100 refrigerator cars from the American Car & Foundry Company.

The Carnegie Steel Company has ordered 12 gondola cars of 70 tons' capacity from the Standard Steel Car Company.

The Union Railroad is inquiring for 20 caboose cars and 12 steel gondola cars of 70 tons' capacity.

The General Refrigerator Lines, Chicago, Ill., is asking for bids on 1,000 refrigerator cars.

The Missouri Pacific Railroad is inquiring for repairs on 250 wooden box cars and 2,250 wooden gondola cars.

The New York Central Railroad has ordered 500 gondola cars of 55 tons' capacity from the American Car & Foundry Company and 500 from the Pullman Car & Mfg. Company.

The Ford Motor Company has ordered 30 caboose cars from the Standard Steel Car Company.

The Charleston & Western Carolina Railway is inquiring for 100 single sheathed cars of 70 tons' capacity.

The National Plate Glass Company is inquiring for 35 high side gondola cars.

The Phillips Petroleum Company has ordered 100 insulated tank cars from the General American Car Corporation.

The Lehigh and New England Railroad has placed an order with the Pressed Steel Car Company for the conversion of 197 gondola cars into box cars

The Norfolk & Western Railway has placed order for the repair of 800 gondola cars with the Virginia Bridge & Iron Company and for 783 with the Ralston Steel Car Company.

The Union Pacific Railroad is inquiring for 500 gondola cars and 500 flat cars.

The Delaware, Lackawanna & Western Railroad is asking for bids on 1,000 steel underframes box cars.

The Canadian National Railways is inquiring for 500 steel underframes automobile box cars.

The Northern Pacific Railway has ordered 500 box cars underframes from the Ryan Car Company.

The Western Union Telegraph Company is inquiring for 20 work cars.

The Chicago, Indianapolis & Louisville Railway is inquiring for 250 composite hopper cars.

The Florida East Coast Railway has ordered 20 caboose cars from the Magor Car Corporation.

The Pere Marquette Railway is inquiring for 11 steel underframes for caboose cars.

The Swift Company, Chicago, Ill., is inquiring for 150 stock cars.

The Baltimore & Ohio Railroad is inquiring for 200 underframes for freight cars.

The Louisville & Nashville Railroad has placed orders for additional 1,000 gondola cars from the Pressed Steel Car Company.

The Western Union Telegraph Co. is inquiring for 10-40 tons' box cars.

The Oklahoma City-Ada-Atoka Railway is inquiring for 50-40 tons' box cars and 50-50 tons' box cars.

The Seaboard Air Line Railway is inquiring for bids covering the rebuilding of 1,000 ventilated box cars, also for 80 caboose cars.

The American Steel & Wire Company has placed an order for 14 gondola cars with the American Car & Foundry Company.

The Baltimore & Ohio Railroad has placed an order for 2,500 gondola cars with the Standard Steel Car Company; also 500 gondola cars from the General American Car Company. This road has ordered 2,000 box cars bodies from the Pullman Car & Mfg. Company.

Passenger Cars

The Baldwin Locomotive Works is inquiring for one inspection car with rear trucks; also for one car body for a steam motor car.

The Chicago, Rock Island & Pacific Railway is expected to enter the market for 5 combination baggage and mail cars.

The New York Central Railroad has placed orders with the Standard Steel Car Co. for 29 motor submarine cars.

The Northern Pacific Railway has placed an order with the Siems Stembel Company for 14 underframes for refrigerator cars.

The Lehigh & New England Railroad has ordered one business car from the American Car & Foundry Company.

The Missouri Pacific Railroad has placed orders for 10 mail storage cars, one combination passenger and mail car with the American car & Foundry Company, 9 combination mail and baggage cars and 6 divided coaches from the Pullman Car & Mfg. Company.

The Great Northern Railway is inquiring for 4 gas electric baggage cars, 4 gasoline driven baggage cars and 4 car sets of trucks with gasoline power plant.

The Union Pacific Railroad is inquiring for 15 baggage cars, 15 coaches, 5 dining cars and 5 observation cars.

The Reading Company has ordered 5 combination baggage and mail cars from the American Car & Foundry Company also 5 combination baggage and mail cars from the Bethlehem Shipbuilding Corporation.

The Missouri Pacific Railroad has placed an order for 2 dining cars with the American Car & Foundry Company.

The Union Pacific Railroad it is reported will be shortly in the market for 40 passenger cars.

Building and Structures

The Louisville & Nashville Railroad plans the improvement of its yards at Memphis, Tenn., including a new roundhouse; the approximate cost will be $150,000.

The Union Pacific Railroad plans extension to its machine shops, enginehouse, etc., at Nampa, Idaho.

The Illinois Central Railroad has awarded the contracts for the roundhouse and shop building at Markham yards near Harvey, Ill.

The Atchison, Topeka & Santa Fe has plans for a store department building and power plant as a part of its shop construction at San Bernardino, Calif.

The Chicago, Rock Island & Pacific Railway has placed a contract covering the construction of two shops at Shawnee, Okla., replacing those recently destroyed by fire.

The New York Central Railroad plans the construction of a $10,000,000 office building in New York city.

The Boston & Maine Railroad has placed a contract covering the rebuilding of the enginehouse at East Somerville, Mass., recently destroyed by fire.

The Sand Springs Railway plans the rebuilding of its machine shops at Sand Springs, Okla., which were recently destroyed by fire.

The Missouri Kansas Texas Railway plans the construction of a roundhouse and enlarging its yards at Ft. Worth, Texas.

The Boston & Maine Railroad will construct a one-story engine house with repair facilities at Boston, Mass.

The New York, New Haven & Hartford Railroad has awarded a contract covering the construction of a three-stall enginehouse at Fitchburg, Mass.

The Old Union Station building of the New York Central Railroad and Erie Railroad at Batavia, New York, which has been used by the New York Central as a blacksmith shop was recently destroyed by fire.

The Pennsylvania Railroad plans the construction of a new enginehouse and locomotive repair shop at Altoona, Pa., to cost approximately $100,000.

The Atchison, Topeka & Santa Fe Railway has authorized the construction of a hospital at Los Angeles, Calif., to cost approximately $350,000.

The Chicago & Eastern Illinois Railway is preparing tentative plans covering an enginehouse, boiler shop, machine shop, forge shop, planing mill and power house, with new freight house and additional trackage, the entire improvement to cost approximately $1,500,000.

The Illinois Central Railroad plans the construction of a new repair shop at Paducah, Ky. These plans include a locomotive erecting shop, car repair shop, blacksmith shop, carpenter shop, wood mill and storeroom, to cost approximately $6,000,000.

The Southern Railway has authorized the construction of a steel coaling station at Selma, Ala.

The Hocking Valley Railway has awarded a contract for the construction of a steel water treating plant with a capacity of 60,000 gallons per hour at Walbridge, Ohio, to cost approximately $50,000.

The New York Central Railroad has awarded a contract to the National Boiler Washing Company, Chicago, Ill., for the installation of a boiler washing system at Brewster, New York.

The Illinois Central Railroad plans the construction of a pumphouse and the laying of five miles of pipe line at the Markham yards near Harvey, Ill.

The Pennsylvania Railroad has placed a contract covering the construction of a machine shop at Pitcairn, Pa., also an addition to its enginehouse at Enola, Pa.

The Atchison, Topeka & Santa Fe Railway is reported to be planning the construction of an enginehouse at Gainesville, Texas.

The Maine Central Railroad plans the reconstruction of its freight car repair shop at Waterville, Maine, which was destroyed by fire. The cost of rebuilding will be $40,000.

Items of Personal Interest

K. F. Nystrom has been appointed engineer of motive power and rolling stock of the Chicago, Milwaukee & St. Paul Railway, with headquarters at Chicago, Ill., a newly created position. Mr. Nystrom was formerly engineer of car design.

George E. Dougherty has been appointed master mechanic of the Buffalo division of the Delaware Lackawanna & Western Railroad, with headquarters at East Buffalo, N. Y., succeeding **H. C. Caswell**, resigned.

P. W. Kiefer, engineer of motive power of the Lines East and West of Buffalo of the New York Central Railroad, with headquarters at New York City, has been promoted to engineer of rolling stock, with the same headquarters, succeeding **F. S. Gallagher**, deceased. Mr. Kiefer entered the equipment engineering department in 1916 and served in various capacities. In July, 1920, he was promoted from the position of chief draftsman in the locomotive department to the position of assistant engineer in the office of the engineer of rolling stock and equipment. In March, 1923, he was promoted to assistant engineer of rolling stock and in May of last year promoted to engineer of motive power. On January 1, he was appointed engineer of rolling stock.

Sam C. Lancaster has been appointed development engineer of the Gulf, Mobile & Northern Railroad, with headquarters at Mobile, Ala.

W. L. Churchill has been appointed chief engineer of the Kansas City, Mexico & Orient Railroad, with headquarters at Wichita, Kan.

F. H. Adams, assistant valuation engineer of the Atchison, Topeka & Santa Fe Railway, has been promoted to mechanical valuation engineer, with headquarters at Topeka, Kan., a newly created position. **W. S. Lammers** has been appointed assistant valuation engineer, with headquarters at Topeka, Kan., succeeding Mr. Adams.

J. E. Stone, assistant master mechanic of the Salt Lake division of the Southern Pacific Company, with headquarters at Sparks, Nev., has been promoted to master mechanic of the Salt Lake division, with headquarters at Ogden, Utah, succeeding **D. Hickey**, who has retired.

A. F. Burke, has been appointed master mechanic of the Southern Pacific Company, with headquarters at Tucson, Ariz. Mr. Burke was formerly general foreman, with headquarters at Roseville, Calif.

T. P. Warren has been appointed division engineer of the Chicago Terminal of the Chicago, Rock Island & Pacific Railway, with headquarters at Chicago, Ill.

J. J. Keller has been appointed assistant master mechanic of the Salt Lake division of the Southern Pacific Company, with headquarters at Sparks, Nev., succeeding **Mr. Stone.**

Homer W. Williams, special representative to the general superintendent of motive power of the Chicago, Milwaukee & St. Paul Railway, with headquarters at Chicago, has been promoted to superintendent of motive power of the Western Lines, with headquarters at Tacoma, Wash., succeeding **Frank Rusch**, deceased. **H. S. Peck** has been promoted to supervisor of locomotives and power plants operations, with headquarters at Chicago, Ill.

C. L. Sitton has been appointed chief engineer, maintenance of way and structures, of the Southern Railway Lines East, with headquarters at Charlotte, N. C.

L. C. Hensel has been appointed chief electrician of the Chicago, Alton Railroad, with headquarters at Bloomington, Ill., succeeding **S. W. Detrich**, who has resigned.

J. P. Morris, general foreman for the Atchison, Topeka & Santa Fe Railway, with headquarters at Shopton, Iowa, has been promoted to master mechanic of the Illinois division, with headquarters at Chicago, Ill., succeeding **James McDonough**, who has retired.

N. J. Boughton, engineer of tests of the Missouri, Kansas, Texas Railroad, with headquarters at Parsons, Kan., has been promoted to mechanical engineer, with the same headquarters, succeeding **B. B. Milner**, resigned.

A. M. Burt, who began work for the Northern Pacific Railway as transit man on a survey for the Coeur d' Alene branch west of Missoula, Mont., in 1889, has been appointed vice-president in charge of operation and maintenance of the Northern Pacific. He takes the place made vacant by the death of Vice-President John M. Rapelje, January 20.

Mr. Burt, who has been assistant vice-president since May 1, 1923, is a native of Syracuse, N. Y., and began his railroad career with the Colorado Midland Railroad in 1885. His service of practically thirty-six years with the Northern Pacific includes positions as division superintendent successively at Jamestown, N. D.; Fargo, N. D.; Missoula, Mont., and Spokane, Wash., during the period from 1903 to 1914. Later he was chief engineer, maintenance of way, then acting general manager, and for nine months in 1919 and 1920 he was assistant director, division of operation, United States Railroad Administration at Washington. On March 1, 1920, he was made assistant to the vice-president, three years later being appointed assistant vice-president.

Supply Trade Notes

David B. Rushmore, one of the consulting engineers of the **General Electric Company**, has resigned his position, and after February 1 will be located in New York City, with headquarters at the University Club. His resignation followed orders from his physician to take a long rest and avoid desk work.

Mr. Rushmore has served 25 years with the General Electric Company and with the Stanley Electric Company of Pittsfield, which was absorbed by the General Electric Company. He went to Schenectady in 1905, and for 17 years was engineer of the power and mining department. Since 1922 he has been one of the consulting engineers. Previous to his service with the General Electric Company, Mr. Rushmore was with the Westinghouse Electric & Manufacturing Company, and later with the Royal Electric Company of Montreal.

He was graduated from Swarthmore College in 1894 with the degree of Bachelor of Science and Engineering, and from Cornell University in the following year in the electrical engineering course. In 1897 he received the degree of Civil Engineer from Swarthmore, and in 1923 the honorary degree of doctor of science from there.

Mr. Rushmore is a member of numerous American and European engineering and technical societies, and of Schenectady and New York clubs.

Carl A. Pinyerd, representative of the **Safety Car Heating & Lighting Co.**, with headquarters at Chicago, Ill., has been appointed district engineer in charge of engineering and service matters.

The **Gould Coupler Co.** and **Gould Storage Battery Co.** of Depew, N. Y., has been purchased by **Charles J. Graham** of Pittsburgh, Pa. Mr. Graham is vice-president of the **Graham Bolt & Nut Co.**, and is interested in the **American Railway Appliance Co.**, but states that the purchase of the Gould interest will not mean that they will be affiliated with either the Graham or American Company. No change in the personnel is involved except that the president, **Charles S. Gould**, will retire, and will be succeeded by his son, **W. S. Gould.**

LeRoy Kramer, vice-president in charge of western sales of the **Symington Co.**, with headquarters at Chicago, Ill., has been appointed vice-president in charge of manufacturing and sales of the **General American Tank Car Corporation**, with headquarters at Chicago, Ill.

Colonel Eugene C. Peck, who was formerly general superintendent and later work manager of the **Cleveland Twist Drill Co.**, has retired from active management. He will continue however as a stockholder in the company and as a member of the board of directors.

James F. Hamilton has been appointed manager of the sales office of the **Worthington Corporation**, with headquarters at Milwaukee, Wis.

Herbert H. Moffitt has been appointed southwestern representative of the **Union Railway Equipment Co.**, with headquarters at Washington, D. C. **S. Clyde Kyle** and **N. Elliott** has been appointed Pacific coast representatives, with headquarters at San Francisco, Calif.

Oscar W. Loew has been placed in charge of advertising and sales promotion work of the **Truscon Steel Co.**, Youngstown, Ohio.

The Franklin Railway Supply Co. of Canada, Ltd., has changed its corporate name to the **Franklin Railway Supply Co., Ltd.** The headquarters will still be maintained in the Transportation building at Montreal, Que., and no change in the personnel is contemplated.

William P. Kirk, district manager of the Cincinnati, Ohio, office of the **Niles Tool Works** and the **Pratt & Whitney Co.**, has been transferred to the New York office of the **Niles Bement Pond Co.**; **E. H. Gates** will succeed **Mr. Kirk**. Mr. Gates was formerly in charge of the office at Rochester, N. Y.

The Zapon Leather Cloth Co., New York City, has changed its name to the Zapon Co. No change in organization or personnel is involved.

The Refrigerator Car Indicator Co., Chicago, Ill., has been incorporated to manufacture and deal in device for installation of automatic weighing scales in refrigerator cars. **B. F. Bates** is president of the company.

E. J. Costello, Jr., formerly with the Pennsylvania Railroad, with headquarters at Pittsburgh, Pa., and later with the Pittsburgh office of the **Truscon Steel Co.** has been appointed sales engineer for the railroad department of that company, with headquarters at New York City.

Lawrence Richardson has joined the **Dwight P. Robinson & Co.**, engineers and constructors, New York. Mr. Richarson was formerly with the Whiting Corporation, with headquarters at Chicago, Ill.

Charles K. Seymour has been elected secretary of the **Niles Bement Pond Co.**, New York City, succeeding **C. D. Guthrie**. **J. B. Cornell**, after 25 years' service, has resigned as treasurer.

John Heller has been appointed sales manager of the **International Acetylene Co.**, Newark, N. J.

At the annual meeting of the **Canadian Car & Foundry Co.** held in Montreal, Canada, **Lorne Webster** was elected a director and **Lewis L. Clarke**, **Andrew Fletcher** and **O. F. Harvey** of New York resigned.

George E. Doke, engineer of materials and equipment tests of the New York Central, at New York, has resigned, effective February 1, and has been elected president of the **Association of Manufacturers of Chilled Car Wheels**, with headquarters at Chicago, to succeed **George W. Lyndon**, who died on October 7, 1924, in Chicago.

George E. Doke was born in Tecumseh, Mich., on August 19, 1877, and was educated in the elementary and high schools of Elkhart, Ind. From 1897 to 1900 he served on the Indiana, Illinois & Iowa (now a part of the New York Central); he also served on the Lake Shore & Michigan Southern as yard clerk, telegrapher, bill clerk and timekeeper. He then entered the shops of the Lake Shore & Michigan Southern as an apprentice, and while serving in this position completed a special course in mechanical drawing and mechanical engineering. In 1905 he entered the chemical and physical laboratory of the Lake Shore & Michigan Southern at Cleveland as a laboratory assistant, becoming chief material inspector of that road's material inspection force in 1906. In 1912 he was promoted to assistant engineer of tests in charge of the locomotive and car department's service tests and in 1916, following the consolidation of the Lake Shore & Michigan Southern with the New York Central, was promoted to assistant engineer of tests in charge of material inspection for the Car and Locomotive Departments for the New York Central System. Four years later he was again promoted to engineer of materials, with headquarters at Cleveland, Ohio, in charge of materials inspection and the creation and development of material spscifications, and two months later was made engineer of tests of the New York Central Railroad in New York City, in charge of chemical and physical laboratories, material inspection bureau, service test department and dynamometer car tests. Since 1922 he has served as engineer of materials and equipment tests of the New York Central Railroad, in which position he has had charge of the Service Test Department, Dynamometer Car Tests, Examination of Failed Materials and the Creation or Development of the Equipment Engineering Department's Material Specifications.

George E. Doke

Mr. Doke for several years past has been an active committee member of the American Society for Testing Materials and the Mechanical Division of the American Railway Association. He is also a member of the Cleveland Engineering Society and the American Society of Mechanical Engineers. His election as president of the Association of Manufacturers of Chilled Car Wheels became effective January 14.

It is questionable whether there are many men in the United States today who have had the long experience in research and experimental work that Mr. Doke has had in the railroad field.

The retention of the chilled cast iron wheel by the railroads is probably an economic necessity. The constantly greater capacities embodied in the more modern designs of cars do, however, present various problems of design and service to which the cast iron wheel manufacturers must give attention.

Mr. Doke is, therefore splendidly equipped to take up the problems that are presented and to carry forward the policy of the association which has in mind the more intensive study of the designs and the broadening of the service capacities of the chilled wheel.

The railroad world will doubtless, therefore, welcome gladly this selection.

Obituary

S. D. Hutchins, representative of the Westinghouse Air Brake Company at Columbus, Ohio, died on January 5 in the Mt. Carmel Hospital, following an abdominal operation. He had been enjoying good health until three months ago, when taken sick during the A. E. R. A. convention last October at Atlantic City.

S. D. Hutchins

Mr. Hutchins was born at Cleveland on May 25, 1855. He began railroading when a mere boy, entering the service of the Springfield, Mt. Vernon & Pittsburgh Railroad (now a part of the Big Four) in 1871 as a fireman, and was promoted to engineer in 1873 before he was 20 years of age. When he left the employ of the railroad in 1896 he was the third oldest passenger engineer on the road and was running the highest class train, the Southwest Limited.

He was an active member of the Brotherhood of Locomotive Engineers and retained his membership even after leaving the railroad.

On May 15, 1896, Mr. Hutchins entered the service of the Westinghouse Air Brake Company as assistant on their air brake instruction car, and in 1905 was advanced to the position of representative, with headquarters at Columbus, which position he held until his death.

He was a member of the Air Brake Association and the Travelling Engineers Association, being president of the former in 1896.

His dignified and commanding appearance won for him the name of "Judge," by which he was familiarly known among his friends.

In view of his broad practical experience and fair mindedness, he has time and again been unanimously selected by railroad officials and employees to act as arbitrator in matters of dispute and invariably brought about a mutually satisfactory settlement.

John Malcolm Rapelje, vice-president of the Northern Pacific Railway, died at 11:15 A. M. Tuesday, January 20, at the Northern Pacific Hospital, St. Paul, Minn. Appendicitis was the cause of death. He had been seriously ill only eight days. He would have been 68 years old January 22.

He was born at Chippawa, Ontario, in 1857, and began railroading as brakeman for the Grand Trunk in 1879. Then he went with the Canadian Pacific, and was a conductor on the first through train from the Atlantic to the Pocific Coast—in 1886.

Later he came to the United States and began firing an engine for the Santa Fe, being promoted within a few months to engineer.

On January 13, 1888, thirty-seven years ago, he joined the Northern Pacific ranks as brakeman on the Yellowstone division. He successively was conductor, trainmaster, superintendent, general superintendent, general manager, and finally vice-president. He was made acting vice-president in charge of operation April 1, 1918, and on December 1, 1921, was made vice-president in charge of maintenance and operation, the position he held when he died.

L. J. Gwinn, for many years an instructor on the Westinghouse Air Brake Company's instruction car, died suddenly on January 5 in Pittsburgh while returning to his home from work in the evening. Mr. Gwinn was formerly connected with the Boyden Brake Company at Baltimore, Md., and went to the Westinghouse Company in 1906 as an inspector. Later he was assistant instructor in the Westinghouse Air Brake instruction car, and was finally put in charge. He was transferred from the instruction car some years ago, to the engineering department at Wilmerding, Pa, and at the time of his death was acting as a technical writer in the patent department.

S. S. De Lano, treasurer and a member of the board of directors of the American Car & Foundry Company, died at his home in New York City on December 27.

Frederick C. Riddle, general manager of the Edgewater Steel Company, Pittsburgh, Pa., died in that city on December 21. Mr. Riddle spent his early business days with the Oliver Iron & Steel Company and the Railway Steel Spring Company. He was appointed general superintendent of the Inter Ocean Steel Company, with headquarters at Chicago, Ill., and when the Edgewater Steel Company was organized he became its general manager.

New Publications

The Enlarged Callendar Steam Tables. By H. L. Callendar, C. B. E., F. R. S. Eward Arnold & Co., London. 80 pages. 5¼ in. by 8½ in.

These tables are essentially tables giving the properties of superheated steam, in fact with the exception of one tabulation of saturated steam they all relate to the superheated condition. These tables are based upon absolute pressure in lbs. per sq. in. and the steam temperature in degrees Fahrenheit. The pressures range from 1 to 2,000 lbs. per sq. in. The tabulation on the basis of pressure rise on increments of 1 lb. from 1 to 20 lbs. per sq. in.; on increments of 2 lbs. from 20 to 100 lbs. per sq. in.; on increments of 5 lbs. from 100 to 200 lbs. per sq. in.; on 10 lbs. from 200 to 300 lbs. per sq. in; on 20 lbs. increments from 300 lbs. to 500 lbs.; on 50 lbs. increments from 500 to 1,000 lbs. per sq. in., and thence on increments of 100 lbs. up to 2,000 lbs. The temperature ranges vary with the pressure. At a pressure of 1 lb. per sq. in. the temperature indications range from 100° to 500° Fahr. and at a pressure of 2,000 lbs. it ranges from 590° to 1,000° Fahr. Under each tabulated pressure there are five indications, namely, for the superheat, total heat, the total heat minus a fixed constant, the volume, and the entropy ratio.

It will be seen that the intervals between the tabulated pressure have been graduated in the same manner as in the majority of tables for saturated steam with larger intervals at the higher pressures, where the values of the entropy and the volume vary more slowly with the pressure.

In his preface the author says that "since experimental results become more uncertain and conflicting at high temperatures and pressures, it is necessary, for purposes of extension to adopt a basis of tabulation, freed as far as possible from minor variations and controversial elements."

He then goes on to explain in considerable detail the methods used in his calculations so that anyone sufficiently interested will be able to follow them, and fill any vacancies that may be necessary to meet individual requirements.

As they stand the tables will probably meet any ordinary demands and they are many in view of the extended use of superheated steam in locomotive practice; so that, now, practically all of the properties of superheated steam are available to the engineer for immediate use.

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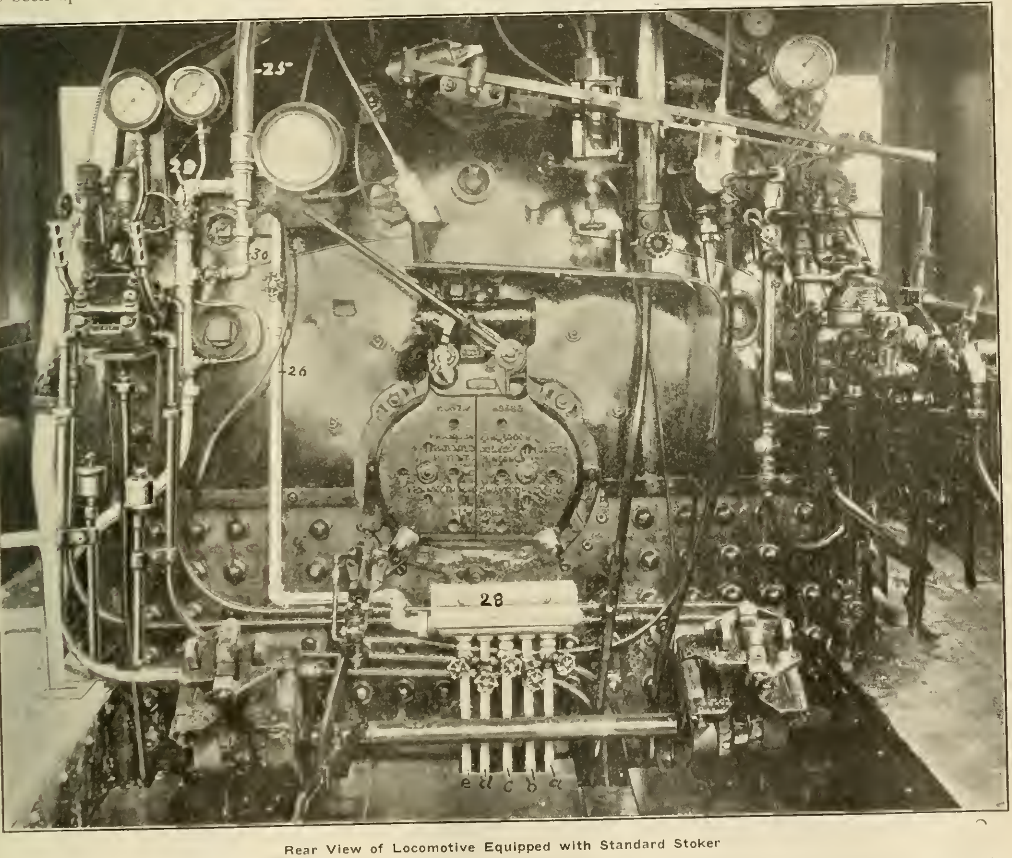
The Standard Stoker

Details in Regard to the Simplification of Its Construction and Efficiency of Operation

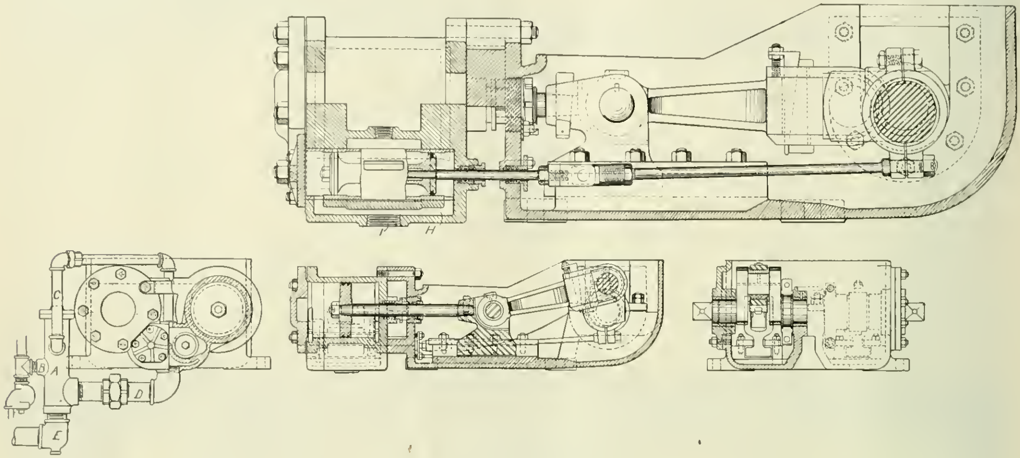
The stoker manufactured by the Standard Stoker Co. of New York and Chicago, and known by the same name has been upon the market for a number of years, and has recently undergone a thorough remodeling and simplification. In the form in which it was introduced the coal was moved from the tender to the locomotive by a horizontal screw conveyor to a point beneath the grates and just ahead of the back sheet of the firebox. Here it was delivered to a vertical screw conveyor working in a tube protected by a grating and carried to a point above the bed of fuel and immediately in front of the fire door.



Rear View of Locomotive Equipped with Standard Stoker

This construction involved the use of gearing beneath the grates by which the vertical screw was operated.

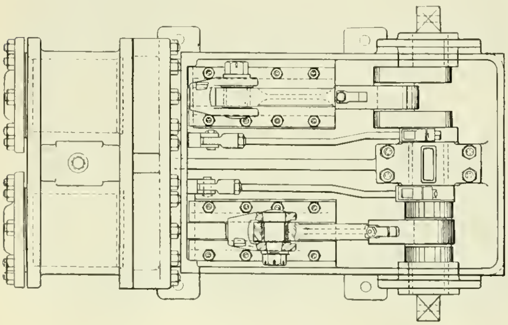
In the new design this gearing as well as the vertical screw has been done away with, and the horizontal screw is driven from the rear, and so arranged as to force the coal up through the vertical pipe without the aid of a screw.



Details of Engine of Standard Stoker

As the coal emerges from the tube at the top essentially the same means as before is used for its distribution over the surface of the grates. That is it is done by steam jets so arranged as to blow it to all parts of the firebox.

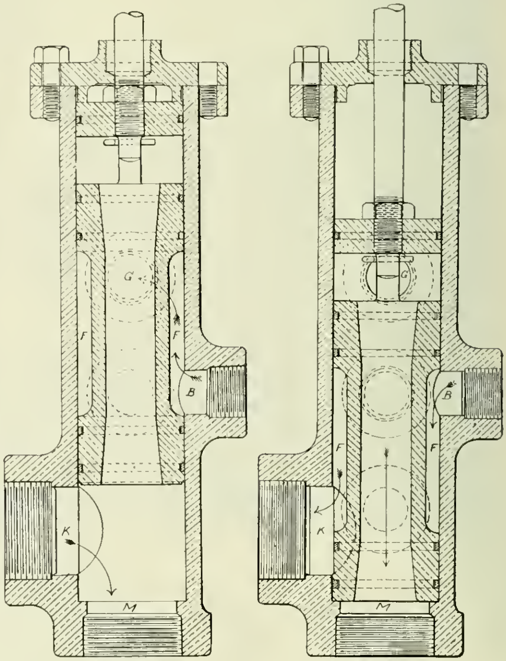
The only moving part of the stoker mechanism proper is the horizontal screw conveyor by which the coal is moved forward from the tender to the locomotive. This is driven by a two-cylinder reciprocating engine that may be run in either direction. The cylinders are 7 in. in diameter with a piston stroke of 7 in. Piston valves 2⅞ in. in diameter, driven by a single eccentric for each cylinder are used. These valves are made without any inside or outside lap, so that steam is admitted for the full length of the stroke at all times. Reversing is accomplished by changing the flow of steam to and from the engine and thus converting the valves from inside to outside admission and *vice versa*. Under ordinary operating conditions the valves operate with inside admission, while for reversal they work with an outside admission.



Plan of Engine

The overall dimensions of the engine are as follows: length 3 ft. 11 in.; width 2 ft. 2 in. and height 1 ft. 2 in. The bed and cylinders are cast separately and are bolted together as shown in the longitudinal section. The cranks and guides are housed within the engine bed so as to be fully protected against dust and the steam chests are placed below and between the cylinders. Lubrication is effected by the splash system and oil leakage is prevented by packing the valve stems and piston rods as they pass through the end of the bed.

The reversing valve differs in form, but not in method



Reversing Valve for Standard Stoker

of operation, from the reversing valves that have ordinarily been used with this type of engine. Instead of the usual flat valve placed in the same steam chest and between the two distributing valves this valve is of the piston type set vertically on one side of the engine as indicated at *A* in the end elevation, and is connected by piping to the cylinders. In this, steam is admitted at *B* to the reversing valve, and under ordinary operation with inside admission, it flows out through *C* to the steam chests, while the exhaust comes back through *D* and out to the atmosphere at *E*.

Referring to the longitudinal or vertical sections of the reversing valve, the steam enters at *B*, and, with the reversing valve in its upper position, flows into the cavity *F* surrounding the valve and out at the hole *G* into the pipe *C* to the steam chests which it enters at the center, operating the distributing valves by inside admission.

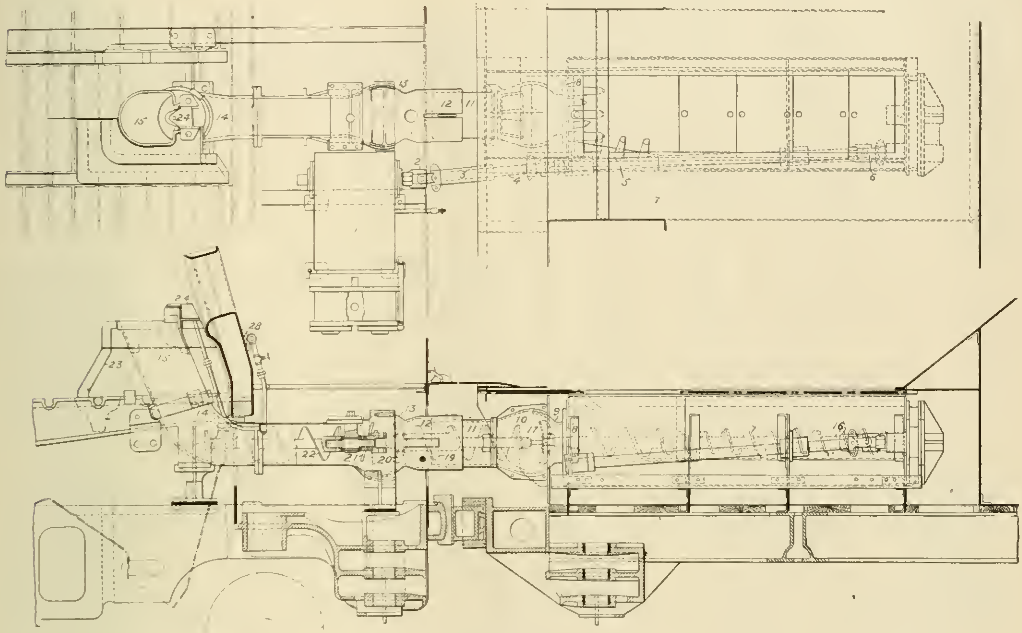
The exhaust comes out at the ends of the valves into the passage *H* and flows out at *I* into the pipe *D* and again enters the reversing valve at *K*, filling the whole interior of the same and escaping to the atmosphere through *M* and the pipe *E*.

If now the reversing valve be moved to its lowest position, the steam entering at *B* as before flows through the cavity *F* and out at *K* into the pipe *D* and enters the ends of the steam chest through the passage *H* and operates the engine by outside admission thus turning it in the reverse direction. The exhaust leaving at the center of the steam chest flows out through the pipe *C* and reenters the reversing valve at *G* and flows down through the center of the valve to the outlet at *M*.

By thus placing the reversing valve in a vertical position, and using a single lever between the valve stem and the operating rod, the latter can be so placed that if stepped on it will hold the engine in the regular operating position and all danger of accidentally reversing the engine obviated.

In the plan of the stoker the engine is shown at 1. It is set on a bracket which is bolted to the top of the rear portion of the frame or cast integrally with it and is beneath the deck of the engine. Its shaft is connected by a gimbal or universal joint 2, to the square telescopic sleeve 3. A mating square shaft 4 enters this sleeve and is rotated by it but will move freely to and fro to allow for any variation in the distance between the locomotive and the tender, or even pull out entirely if the latter is disconnected.

These two parts span the gap between the locomotive and the tender, and the shaft at its back end is connected by another gimbal joint 4 to the shaft 5 which extends back nearly to the rear of the coal space, where it, in turn, is connected by a third gimbal joint 6 to a shaft carrying a spur pinion 4 in. in diameter and cut with 16 teeth of $2\frac{1}{2}$ in. face, that mesh with a gear 16 in. in diameter and 64 teeth, so that the ratio of speed of revolution of the engine shaft to that of the gear is as four to one. This spur gear is mounted on a short shaft having bearings on each side of and close to the gear. At its forward end it is made $2\frac{1}{4}$ in. square for a distance of 4 in. and this square enters a socket in the rear section of the conveyor screw, and so drives the whole conveyor system.



Plan and Sectional Elevation of Standard Stoker

All parts of the stoker are of sufficient strength to withstand, in case of jamming, the power of the engine when working under full boiler pressure.

The gear housing is at the back end of the trough 7, which is supported on the frame beneath the floor of the tender and has a width of 30 in. at the top and a depth of 16 in. with a rounded bottom of $4\frac{1}{4}$ in. radius. This trough is covered by sliding plates that can be moved so as to permit the front edge of the coal in the tender to drop down on the screw conveyor to be carried forward. The trough extends forward to the back end 8 of the inside bowl 9 of a spherical joint which is the entrance to a circular conduit leading forward to the locomotive. This inside bowl carries a hanging bracket 9 in which a brass bushing is pressed to serve as a bearing for the front end of the tender conveyor screw, as will be described later.

The outside bowl 10 of the spherical joint has a tube 11 bolted to it that telescopes into a similar but larger tube 12 forming the rearward extension of the inside bowl 13 of a similar spherical joint attached to the locomotive, these two tubes forming the intermediate section between the engine and tender. The front conveyor trough which is covered starts with the outside shell of the spherical joint on the locomotive and runs forward and terminates in an elbow 14 to the outlet of which the vertical housing 15 is bolted.

This arrangement forms a closed conduit from the rear of the spherical joint on the tender to the point of delivery of the coal in the firebox. The space between the engine and the tender is spanned by the telescope joint which permits the distance between the two to be varied, and, in case the tender becomes disconnected the joint simply pulls apart, while any vertical or lateral movement between the two is taken care of by the action of the spherical joints.

As already stated the square extension of the gear shaft enters a socket at the back end of the tender conveyor screw 16. This screw extends from the front face of the gear housing to the inside bowl at the center of the spherical joint on the tender. Here its central shaft has a bearing in a bushing in the bracket 9 and is lubricated through the oil hole shown in the detail drawing.

The screw itself is of varying pitch and diameter. The two front flights have a diameter of 7½ in. and a pitch of 9 in. Then in the next half flight the screw tapers down to a diameter of 6 in. with a pitch of 6 in.

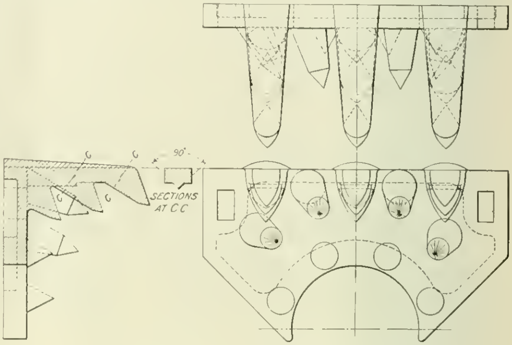
On the flights of 6 in. diameter, raised segments are placed, as shown in the superimposed section, which have an outside diameter of 7 in. with the ends radial. These segments are spaced every one and a half turns of the flight and are diametrically opposite each other, the center of the first segment being located 2⅝ turns from the front end. They each have a length of one-quarter of a turn; and, with their sharp edges serve to cut into and stir the coal, thus preventing it from banking or arching.

At the spherical joint in the conduit it is necessary to have a universal joint in the conveyor screw in order to compensate for the movements between the engine and tender that may occur. This is accomplishd by the use of universal joints.

The front end of the screw is squared with sides 2 in. across, and this sets into and is loosely pinned to a square socket in the back side of the rear paddle and clevis 17. This clevis carries two sections of a flight of the screw as shown in the detail. Each of these sections extends through 90 degrees and varies from a diameter of 12½ in. to 10 in., and serve as extensions of the screw to keep the coal moving between the rear and intermediate sections of the conveyor.

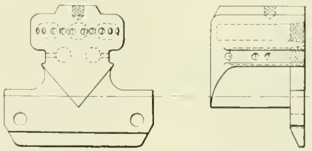
The front portion of the clevis and paddle is coupled by means of a universal joint pivot block, with the back end of the intermediate conveyor screw 19.

This is a short length of conveyor screw having a diameter of 9 in. and a pitch of the same dimensions, that serves to span the distance between the tender and the engine. At its front end it is made with a socket 10 in. deep and 2½ in. square. Into this socket the square stem of the front paddle and clevis 20, is fitted. This piece also carries two 90 degree sections of a flight of the conveyor screw, by which the coal is kept in motion

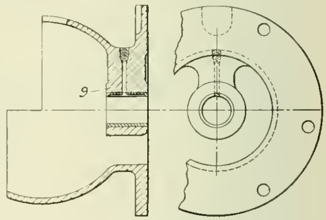


Coal Crusher for Standard Stoker

and delivered to the rear end of the front conveyor screw paddle and clevis 21, which also carries two sections of a flight, similar to the others except that they extend over about 120 degrees each. The front of this paddle and clevis is fitted with a socket 2 1/16 in. square into which the squared end of a manganese steel shaft is entered and pinned. This shaft runs in a manganese steel bushing that is held by a bracket just ahead of the out-



Steam Jet



Inside Bowl of Spherical Joint

side bowl of the front spherical joint, no lubrication being used.

The front end of this shaft is also squared and sets into and is pinned to a socket in the back end of the front section of the conveyor screw 22. The flights of this screw have a pitch of 9 in. and a diameter of the same, except for the last turn in which the screw tapers down to 6 in. and abruptly ends. In addition to this there is a double flight used for this last turn. This screw ends in the elbow 14 beneath the vertical housing 15. It is this sharply ending double flight screw that made it possible to do away with the vertical screw originally used, and force the coal up to the top.

Back at the entrance to the rear spherical joint two crusher plates are bolted in the tender trough. These consist of steel castings, bolted to the tender trough, carrying a number of sharp pointed fingers, and as the coal is brought forward by the conveyor screw any lumps that are forced against these fingers are so broken that they are suited for use in the firebox and can be distributed by the steam jets.

The whole arrangement of the driving mechanism, both in the main shaft, the conveyor screw and the conduit is not only so arranged that its telescopic parts are readily separated but its flexibility is such that, besides taking care of the ordinary movements of the engine and tender, the latter could be derailed and moved a considerable distance from the rails before the joints would be so cramped as to be distorted or injured.

The vertical housing at the front is protected by a grating 23, that sets down over it. This grating permits of a flow of cold air up and about the housing and its escape into the firebox through and above the bed of fuel where it supplies a portion of the air needed for combustion.

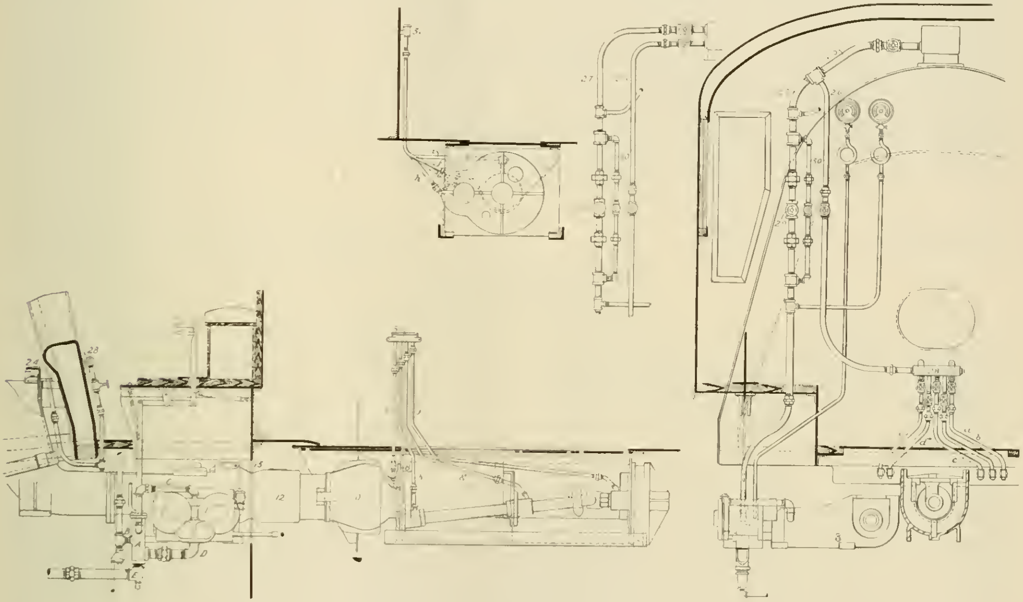
We now come to the method of distribution of the coal in the firebox after it has reached the top of the vertical housing. This is done by means of steam jets the regulation of which are under the control of the fireman.

The distributor jet 24 is of cast iron and is bolted at the top of the protective grating. It is shown separately in detail and is formed with five chambers each having small openings which direct the blast in different directions. These chambers are in two tiers. The upper tier contains three chambers, with openings directing the steam and so driving the coal to the front and sides of the firebox, while the lower tier contains two chambers whose openings and jets project the coal into the right and left rear corners of the firebox respectively. The velocity with which the steam issues from the jets and consequently the distance that the coal is driven by them is controlled by ordinary globe valves placed in the pipes leading to them.

Referring to the engraving of the piping it will be seen that from the single pipe 25 leading from the turret two branches are taken off. One, 26, supplies the distributing jets and the other, 27, supplies the engine. The pipe 26 runs down to a manifold that is placed just beneath the firedoor and from this the five pipes *a*, *b*, *c*, *d* and *e* are led off to the several chambers of the distributing jet. These pipes run down beneath the foundation ring of the firebox and turn up on the inside and enter the distributing jet casting from the rear, under the protection of a jet protecting hood.

With all valves wide open the steam would enter the distributing jet under full boiler pressure, and it is by the regulation of this pressure by means of the valves shown in the pipes *a*, *b*, *c*, *d*, and *e* that the fireman is enabled to control the distribution of the coal and place it in whatever portion of the firebox he may desire.

As for the other steam pipe leading to the engine, this runs down with its full size to the engine and in it there is the throttle valve 29. Then in addition to this there is a smaller by-pass pipe 30 with a valve in it, thus making two throttle valves for the control of the engine. The object of this is to provide the fireman with a more delicate means of controlling the speed of the engine than would be possible were only the large valve available. Yet this large valve may be needed in case of heavy work to be done as may occur in the case of the clogging of coal at the crusher or elsewhere.



Arrangement of Piping for Standard Stoker

In connection with this engraving of the piping attention is called to the four compartment oil box 31, from the bottom of which pipes are led down to the several bearings on the tender that need lubrication. One pipe *f* leads back to the bearings of the gear shafts; a second *g* and third *h* to the bearings of the drive shaft, while the fourth carries oil to the top of the inside bowl 9 for the lubrication of the bearing at the front end of the rear conveyor 16.

The simplicity of the stoker is apparent from this description and engravings. To recapitulate there is an ordinary reversible engine of the simplest type on the locomotive and from this a shaft runs back to a pinion on the tender that drives a spur gear at the back end of the conveyor shaft. This covers all of the moving parts. The conveyor carries the coal forward and up to the top of the vertical housing from which point it is distributed over the firebox by the steam jets that are under the control of the fireman.

As to the efficiency with which the stoker can be made to work, experience on a single run may serve as an illustration.

The engine was of the mountain type having cylinders 29 in. in diameter and a piston stroke of 28 in. and a fire-box 132 in. long and 96 in. wide on the inside. The train consisted of ten steel cars and the run was for a distance of 102 miles over a slightly undulating, but, on the whole an ascending grade. The running time was 2 hours and 45 minutes with one stop. At the start the steam pressure was 190 lbs. and in ten minutes it had risen to 200 lbs. It did not fall below 195 lbs. during the trip except at the stop where it was allowed to drop to 190 lbs. In pulling out from this stop the work was on an adverse grade of about 0.14 per cent. Both injectors were put on and the engine worked hard with the throttle wide open. Yet in 3 minutes the steam pressure had risen to 195 lbs.

Just before starting from the terminal the fireman trimmed the fire by throwing in a half dozen shovelfuls of coal, and that was the last. The fire was not hooked nor was any more coal put in with the shovel. It was a case of 100 per cent work on the part of the mechanical stoker throughout.

During the whole run the fireman had full control. As he was carrying a thin fire of not more than 5 in. in depth over the main portion of the grate, an occasional hole would start to be burned out, then coal was directed to that particular spot and straighway there was a fully glowing bed over the whole surface of the grate. The method of firing adopted was that of carrying a thin bed over the center of the grate, with a thicker one along the side sheets and a deep bank along the back sheet and especially in the back corners.

While the fireman made no use of the hook or shovel on the run he was almost constantly busied with the adjustment of the steam blasts and the speed of the engine, though the latter received the major portion of his attention, as there was only an occasional adjustment of the blasts.

The engine was run throughout the whole trip by steam admitted through the by-pass pipe only.

As the engine and conveyor are located beneath the foot plate and the vertical housing is inside the firebox, there is nothing, aside from the piping, in the cab to indicate the presence of a stoker on the engine. As this piping is of small diameter it is scarcely noticeable, so that the back head and the cab, as will be seen from the reproduction of the photograph, is as free from obstruction as though there were no stoker and the firedoor is ready for hand firing, at once, should occasion arise.

Southern Pacific's New 4-10-2 Type Three Cylinder Locomotive

The American Locomotive Company has under construction for the Southern Pacific Company sixteen three-cylinder locomotives of the 4-10-2 wheel arrangement. These will be used in passenger and freight service over the Sierra Nevada mountains where the maximum grade is 2.2 per cent.

A number of new features are included in the design that are calculated to make for increased power and fuel economy. These were worked out by F. E. Russell, Mechanical Engineer and his assistants under the supervision of George McCormick, General Superintendent of Motive Power of the Southern Pacific, in co-operation with the engineers of the American Locomotive Company. For this reason and the fact that this is the first of the type with the 4-10-2 wheel arrangement, the locomotive has been termed the "Southern Pacific Type."

The steam pressure will be 225 pounds and the maximum cut-off used is 70 per cent instead of 85 per cent. This permits the use of steam more expansively thus reducing fuel and produces a greater power output at any given cut-off through the increased boiler pressure above their usual 200 pounds.

It is estimated that the hauling capacity of the new locomotive due to increased tractive power and more uniform pulling torque because of the third cylinder, will be one-fourth greater at 25 miles per hour on a 2.2 per cent grade than the most powerful units now in use.

The tender has a capacity for 12,000 gallons of water and 4,400 gallons of fuel oil. Each of the driving wheels is 63½ inches in diameter. Main rods of the outside cylinders propel the third pair of driving wheels, while the main rod of the inside cylinder propels the second pair of driving wheels by means of a crank axle.

The use of third cylinder, in addition to providing increased power and economies, has distinct advantages in distributing stresses on two driving axles with consequent reduction in wear and stresses on other mechanical parts.

The diameter of cylinders is considerably reduced resulting in lighter reciprocating parts. This, in conjunction with the application of power to two driving axles, instead of one, very materially improves counter balance conditions. Furthermore, with cranks being set at 120 degrees instead of 90 degrees as on two cylinder locomotives, the combined effect of two counter balances on the rail and on the locomotive at one time is eliminated. All of this results in about one-third reduction of stresses set upon road-bed and bridges due to counter balance, thus enabling reduction in dynamic augment by increasing static wheel loads.

Each locomotive is 101 ft. 1 in. in length over all, has a total wheel base of 87 feet, 2¼ inches, and weighs 682,400 pounds. Maximum tractive power is 96,530 pounds.

Two rather interesting charts have been developed by the Southern Pacific Company to show graphically the advance in locomotive development. One shows the manner in which hauling capacity has been increased in the last thirty years, the base line depicting the power at various speeds of the 4-6-0 type passenger locomotive placed in service thirty years ago and specially designed for hauling the company's early Overland Limited trains between Rocklin and Truckee, a distance of 164 miles, having a maximum grade of 2.2 per cent.

Intermediate lines on this chart show the constant progress of locomotive development to that of the "Southern Pacific type," which will be used to haul heavy trains of the present era over the difficult Sierra Nevada Mountain grades.

This chart shows in detail a comparison of the hauling capacity of these two locomotives at various speeds. Line "A" shows the net hauling capacity, or drawbar pull back of tender, for the Ten-Wheel type locomotive placed in service in 1895. These locomotives were considered the very best that could be built for that service at the time. They were constructed at the Cooke plant of the American Locomotive Company.

Line "B" represents the drawbar pull at various speeds of a plain saturated steam locomotive with the same weight on drivers as the Southern Pacific type and having the same ratio of tractive power to adhesive weight as obtained on the ten wheel type locomotive represented by line "A." The space between lines "A" and "B" shows the increase in drawbar pull at various speeds that has been accomplished in locomotives on account of increase in size only.

Line "C" shows the increase in hauling capacity at various speeds that has been added by the use of superheated steam, instead of saturated steam.

Line "D" depicts the manner in which the development of the feedwater heater has given increased power at various speeds above that obtained through increase in size of locomotives and through the use of superheated steam.

Line "E" shows the increased power obtained by use of the third cylinder, while line "F" shows the hauling power of the Southern Pacific type locomotive, with its three cylinders and with increased boiler pressure and 70 per cent maximum cut-off. The shaded section shows the equivalent increase in drawbar pull due to more even pulling torque exerted on driving wheels. Added power at lower speeds due to use of the auxiliary booster engine is shown by line "G."

The second chart is especially interesting, in that it reveals in an outstanding manner the increase in hauling capacity obtained by the Southern Pacific in thirty years of improvement and development of the steam locomotive an hour, 60 per cent at 15 miles an hour, 43 per cent at 20 miles per hour, 51 per cent at 25 miles an hour, 75 per cent at 30 miles an hour and 129 per cent at 35 miles an hour.

In conjunction with this phenomenal increase in hauling capacity, by refinements in design and use of fuel saving devices, a fuel saving of 32½ per cent is being accomplished.

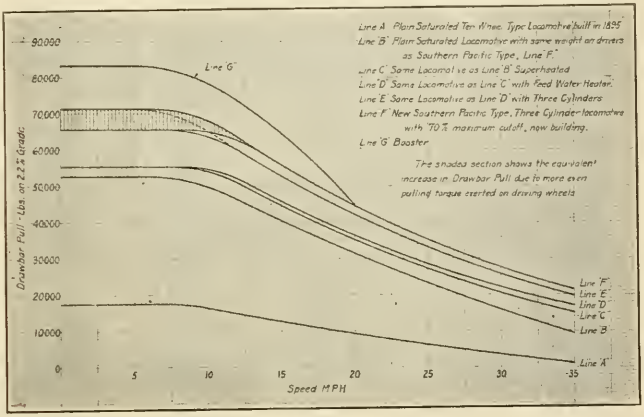


Chart Showing Manner in Which Hauling Capacity of Locomotives Has Increased in 30 Years

Type	Ten-wheel	Southern Pacific
Wheel arrangement	4-6-0	4-10-2
Cylinder diameter	20"	25"
Cylinders, number of, and stroke	Two 26"	One 28", two 32"
Boiler pressure	180 lbs.	225 lbs.
Valve gear, type	Stephenson	Walschaert
Weight on drivers	112,050 lbs.	315,000 lbs.
Weight of engine	142,350 lbs.	440.000 lbe.
Weight of tender, loaded	107,020 lbs.	242,400 lbs.
Total weight of locomotive	249,370 lbs.	682,400 lbs.
Tender capacity—water	4,500 gals.	12,000 gals.
Maximum tractive power		96,530 lbs.
Tractive power without booster	25,260 lbs.	84,200 lbs.
Cylinder horsepower (Cole)	868	3807
Weight on drivers: Total weight of engine %	.787	.716
Weight on drivers: Tractive power	4.43	3.74
Weight of engine per one horsepower	164 lbs.	115.58 lbs.

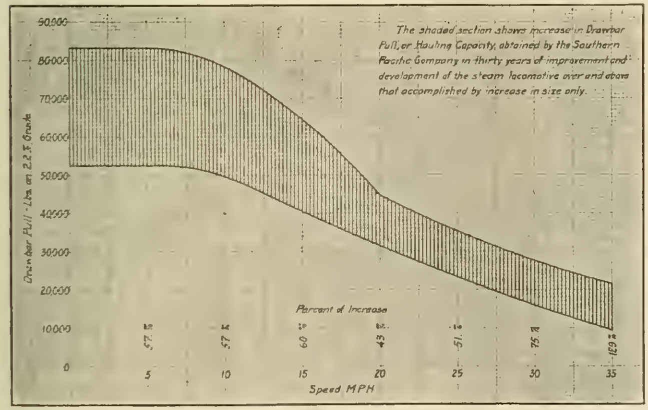


Chart Showing Increase in Hauling Capacity of Locomotives Above That Accomplished by Increase in Size Only

over and above that accomplished by increase in size only.

This increase, it will be noted, varies at different speeds of the locomotive, being 57 per cent at five or ten miles

This means that, with the modern improvements, the new locomotive will require about one-third less fuel to perform the same work as the locomotive of 30 years ago.

Interesting comparison of the old Ten-Wheel and the new Southern Pacific type locomotives is shown in the table.

This comparison between the new Southern Pacific type and the Ten-Wheel locomotive of thirty years ago shows that with an increase of 174 per cent in total weight of locomotive, an increase in tractive power of 233 per cent and an increase in maximum horsepower of 338 per cent has been accomplished. With an increase of maximum static load of 70.2 per cent, the maximum axle load combined with dynamic augment at 50 miles per hour has only been increased 48.3 per cent.

The Southern Pacific 4-10-2 type locomotive represents the latest development of the three-cylinder design. In it are embodied all of the latest principles developed in recent years to increase hauling capacity. It is the most powerful, non-articulated, locomotive yet designed by mechanical experts.

Locomotive Feedwater Heating*

By L. G. PLANT, Assistant to President, National Boiler Washing Company

Recent developments in feedwater heating represent the most fundamental improvement to locomotive economy since the advent of superheating. The application to railway motive power of a long established practice for feedwater heating in stationary power plants is only another belated response to the same economic cause that led to the introduction of superheated steam and other revolutionary changes in locomotive practice.

The underlying economic cause for the American revolution in locomotive design may be broadly designated

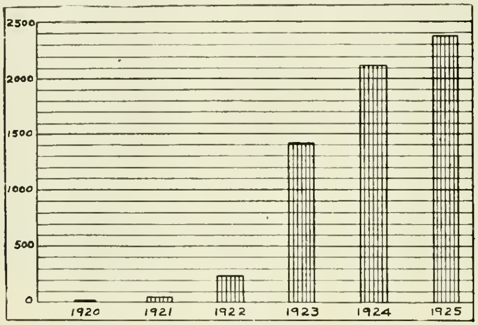


Chart Showing Yearly Increase in Number of Feedwater Heaters in Service

as the growth in railway traffic. Compared to this factor the effect of basic transportation costs is of secondary importance. Had the freight traffic density per mile of track remained the same in 1920 as in 1900, it would have necessitated the construction and maintenance of more than 300,000 miles of additional main line trackage to have accommodated the growth in freight actually handled by the railways. Conservation of enormous expenditures for the construction and maintenance of additional main line trackage is the modern locomotive's greatest contribution to transportation efficiency. Compare the growth in main line trackage since 1900 with the increase in freight handled over these lines as illustrated in the chart. Every increase in freight handled over a mile of main line track during a given period requires the movement of more trains, or of heavier trains, or of more net tons in relation to the total weight of the trains. All of these factors have contributed to the enormous increase in the tons of freight handled per mile of main line trackage since 1900. But the number of trains that can be moved over a mile of track in a given period is limited, and, as a matter of fact, the number of freight trains operated per mile of main line, second and additional trackage declined from an average of 6.5 trains per day in 1900 to an average of 5.6 trains per day during 1920.

Statistics showing the gross weight of freight trains in relation to the net tonnage handled are not available for the corresponding period, but this factor cannot account for a very large increase in traffic density, since it is subject to the individual loading requirements of shippers. Furthermore, increases in the size and structural weight of freight cars have often lowered the ratio of the net lading actually handled to the gross weight of freight trains.

The increase in freight traffic density since 1900 has therefore been very largely accomplished by increasing the average weight of trains. This has required a corresponding increase in the average output of each motive power unit. It is the urge for more and more individual capacity within the weight and clearance limitations to which each locomotive is subject that has led to the adoption of more efficient equipment.

The value of improvements in motive power design and equipment are often appraised upon the basis of their ability to save fuel but in actual service the greatest advantage is usually derived from their capacity for increasing the output of the locomotive. The effect of utilizing locomotive efficiency primarily as a means for increasing its capacity has been to lower the cost of fuel, wages and locomotive maintenance per freight ton mile and effect a corresponding reduction in passenger train costs.

The combined effect of operating more powerful and more efficient motive power units is illustrated by the chart showing the trend in unit operating cost. This chart is taken from statistics for Class I railroads compiled by the Interstate Commerce Commission. The item of wages includes both enginemen and trainmen, while maintenance comprises locomotive repairs and enginehouse expense. It is particularly significant to note that excepting the year in which a strike occurred, maintenance costs show a consistent decline. In the light of these figures it is clear that development of the modern locomotive by application of specialties and refinements in design has not increased its maintenance cost in proportion to the work performed but has enabled the railways to make a reduction in the cost of locomotive maintenance per ton mile comparable with the reductions in fuel and wages per ton mile.

Those same economic forces that have promoted the development of modern motive power will continue to

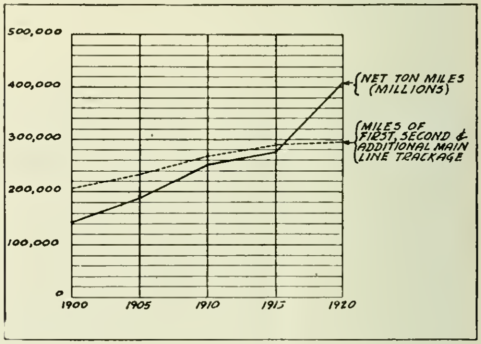


Chart Showing Growth in Railway Mileage and Traffic

compel greater individual capacity with coincident improvements in locomotive efficiency to counteract the inevitable increases in unit prices for fuel and labor. Agitation for railway electrification is urged principally upon the assumption that it would provide more powerful operating units and apply central power station economies to propelling trains. With the anticipated increase in wage and fuel costs, electrification must be regarded as an impending development unless all of the fundamental principles commonly contributing to stationary power

*A paper read before the Central Railway Club, Buffalo, N. Y.

plant economy can be generally applied to locomotive operation. (Mr. Plant here showed slides and described briefly the principal types of feedwater heaters, condensers and the turbine condensing locomotive.)

Each of the several types of feedwater heaters that have been described afford so practical a means for applying to locomotive operation a practice that has long been regarded essential in every efficient stationary power plant that it is difficult to understand why the application of this equipment has been so retarded. Aside from the inertia that accompanies every departure from accustomed practice, there are certain features in the application, operation and maintenance of live steam injectors that exert a strong hold on locomotive practice, so admirable is this device adapted to its requirements. From the standpoint of reliability in service, simplicity in operation and ease of maintenance, there is no locomotive water feeding device comparable with the live steam injector.

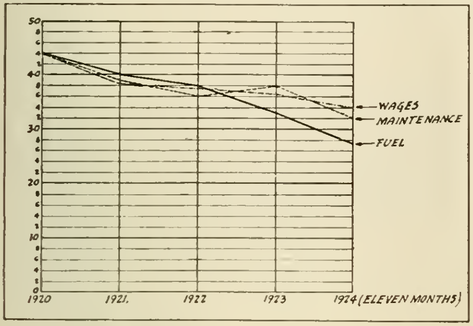


Chart Showing the Trend in Unit Operating Costs

Methods of Testing Can Be Improved

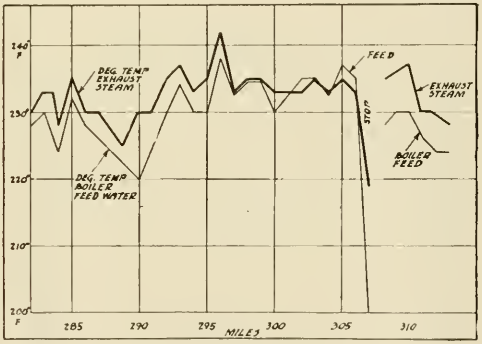
Another factor that has retarded the development of locomotive feedwater heating is the lax and indecisive testing methods to which the application of this equipment is frequently subject. The speaker recalls that about ten years ago he had occasion to investigate the performance of a Caille-Potonie feedwater heater that had been tested on a southeastern railroad some years prior. This is a closed type of heater which was developed in France many years ago and is now extensively used in that country. One of the directors of the American railroad had become interested in the possibilities of such equipment and a heater of this type together with the pump and accessory apparatus had been imported for test on the railroads in this country. The only record of this test disclosed in the files was a report to the superintendent of motive power to the effect that the road foreman had made two round trips on the locomotive and had not noticed any improvement in performance due to the application of the feedwater heater. As a result of this exhaustive test the apparatus was dismounted from the locomotive without further investigation and shipped back to France. "Tests" of this general character have cost American railroads a good many millions of dollars.

It is significant that railroads on which the most exhaustive tests of locomotive feedwater heaters have been made are now becoming the most extensive and consistent users of this equipment. There is no lack of authentic data on the performance of locomotive feedwater heaters available to any railroad that is not in a position to make exhaustive tests of this device. In fact, the technical aspects of locomotive feedwater heating are no longer problematical. Tests to determine the practicability and value of this practice are as out of date as similar tests of the superheater. On matters other than maintenance the relative efficiency of types and improvements to existing equipment, etc., sufficient data is already available and the question of applying feedwater heaters is entirely an economic problem.

Where tests are made, it is particularly important in the case of the locomotive feedwater heater to concentrate attention upon those factors that are strictly relative to the actual value or relative merits of this equipment. Otherwise, the real issues involved may be obscured by a mass of irrelevant data and over-all generalities. The first consideration is that of temperatures attained by water in relation to the temperature of exhaust steam available for heating. Next comes the cost of maintaining this equipment with particular reference to the facilities available for this purpose.

The most important operating characteristic of a locomotive feedwater heater is the temperature at which it can deliver feedwater to the boiler. The economy from feedwater heating increases with each degree rise in temperature of the water delivered to the boiler. Under the conditions usually assumed for locomotive operation, every 12½-degree increase in feedwater temperature accomplished by waste heat represents an increase of one per cent in the steaming capacity of the locomotive. (Mr. Plant here showed curves representing a record of both the feedwater and exhaust steam temperatures observed at different rates of evaporation in the Pennsylvania tests of a decapot type locomotive equipped with an open-type feedwater heater.)

The gain in locomotive efficiency by feedwater heating can be determined from these temperatures after the heat



Temperature Record of Canadian National Elesco Locomotive Equipped with Feedwater Heater

content in steam used by the pump has been deducted and the effect of any reduction in back pressure on account of exhaust steam diverted to the feedwater heater has been credited to its performance. No tests of this equipment are complete without a complete record of exhaust steam and feedwater temperatures, a measure of the steam used by the pump and a determination of the back pressure in operation.

A partial record of the feedwater and exhaust steam temperature in the test of a Canadian National Mikado type freight locomotive equipped with a closed-type feedwater heater is illustrated.

Feedwater Heating at Locomotive Terminals

A consideration of the situation at all important locomotive terminals will further enlarge our conception of the realties and possibilities of locomotive feedwater heating. It is estimated that approximately 20 per cent of all locomotive fuel is consumed at terminals. A considerable part of this fuel is consumed in firing up locomotives and the amount required for this purpose depends upon the temperature of the water with which the locomotive boiler is filled. The law requires all boilers to be emptied and washed at least once each month and on many railroads operating conditions necessitate refilling boilers much more frequently. Equipment for washing and filling locomotive boilers with hot water has been generally regarded as merely a convenient maintenance facility.

With the emphasis that is being placed on the economy of feedwater heating on the road, it is only appropriate to direct attention to the fact that it requires about 1,200 pounds less coal to fire up a modern locomotive filled with water at a temperature of 180 deg. than when the locomotive boiler has been filled with cold water. If the heat required to elevate the filling water to this temperature is reclaimed from the heat content of steam blown off from incoming locomotives, this reduction of 1,200 pounds coal in the quantity of fuel required to fire up the locomotive represents a true saving. One of the illustrations shows the equipment required to obtain this economy, indicating the separator into which the blown-off water and steam from incoming locomotives is first discharged. The water gravitates to the washout tank from which it is drawn for boiler washing purposes. The exhaust steam flows to twin condensers of the jet type, and here again we have an application of the principle involved in the operation of the open-type feedwater heater. Fresh, cold filling water flows to the reservoir from which it is drawn for filling locomotive boilers at temperatures ranging from 180 to 210 deg. Higher delivery temperatures are not practical since the system is operated at atmospheric pressure.

Building Up Feedwater Temperature and Boiler Pressure by Direct Steaming

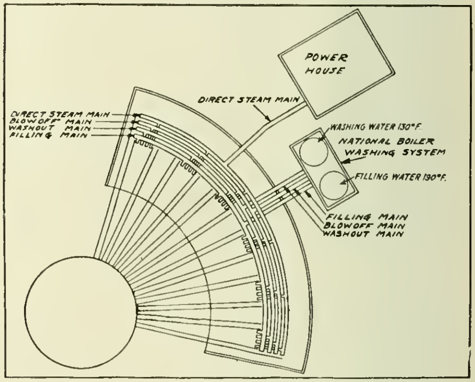
Tests recently conducted on a western railroad develop the fact that for each 20 deg. increase in the temperature at which the locomotive boiler is filled there is a saving of about 8 gal. of oil or its coal equivalent in the quantity of fuel and approximately 10 min. in the time required to fire up a large Mikado type locomotive. These tests, however, are related to a new and even more significant aspect of locomotive feedwater heating at terminals. This is the direct injection of live steam and hot filling water by means of the system of mains shown in one of the drawings. The use of live steam drawn direct from a stationary power plant as indicated together with hot filling water, enables a locomotive to be filled and steamed up to a pressure approximating the stationary boiler pressure without lighting the fire in the locomotive firebox. The time required for this operation is about the same as in the usual procedure, but there is a gain in efficiency due to the elimination of the houseblower which ordinarily consumes steam at the rate of 40 boiler hp. per hour or higher. Furthermore, steam supplied from modern stationary boilers can be more efficiently generated than in a locomotive boiler during the firing up stage so that there is a further gain in efficiency on this account. The elimination of smoke and of blower steam within the enginehouse are factors of no little importance. The operation of smokeless enginehouses in which all locomotives are steamed up by this method can be anticipated. In this case all fires would be dumped before locomotives are placed in the house and the fires are not lighted until the locomotive is placed in a firing-up shed adjacent to the enginehouse.

The enginehouse pipe connections required for this method are illustrated. These provide a live steam drop in connection with the hot filling water main and a blow-off connection. In filling a locomotive both the live steam and filling water valves are opened and the boiler filled through the blow-off valve with this mixture of steam and water. As soon as the water shows in the glass it is shut off and the steam allowed to flow into the boiler until the desired pressure is built up. With this arrangement, it is possible to hold locomotives under a working steam pressure. If the fire is lighted as soon as the water shows in the gage glass, the time required to fill and steam up modern locomotives to a working steam pressure can be reduced to approximately half an hour.

Feedwater Heating No Longer a Problem of Technique

Locomotive feedwater heating in all its aspects is no longer a problem of technique but of economics. When the requirements are really understood it will be found that equipment is available to do almost anything actually desired in this direction. The economies that will result from this practice are based on physical laws that are as old as creation and as fundamental to the locomotive as the generation of steam itself.

The railways in this country now own over 65,000 locomotives. Approximately 44,000 of these locomotives are equipped with superheaters and it is estimated that the



Plan of Enginehouse to Provide Direct Injection of Live Steam and Hot Filling Water into Locomotive Boilers

railways could profitable extend the use of superheated steam to at least 60,000 locomotives. With the annual retirement of saturated steam locomotives and modernization of old power continued in service, it is expected that this proportion of superheated steam locomotives will be attained. The application of feedwater heating in some form should logically follow the use of superheated steam. On certain classes of old motive power the feedwater heater or exhaust steam injector may precede the superheater owing to the greater facility with which it can be applied. Feedwater heating has a lesser effect upon locomotive operation than superheating, but these two developments are associated since they effect locomotive performance in a corresponding manner and the field for superheating is so well defined that it affords a good index to the possibilities for locomotive feedwater heating.

The application of locomotive feedwater heaters is responding rapidly to a growing appreciation of the essential character of this equipment. There are now more than 2,400 locomotive feedwater heaters in use on American railroads compared with 7 locomotives equipped for feedwater heating in 1920. The eventual extension of this practice to 60,000 locomotives will probably increase the investment in motive power on Class I railroads by 110 to 125 million dollars. It should enlarge the potential operating capacity of these locomotives by at least 10 per cent, which in a general way is equivalent to adding some 6,000 locomotives to the total number available for service. Or, expressed in another way, the application for feedwater heating to approximately 60,000 locomotives will forestall the purchase of at least 6,000 locomotives of the present calibre. At current motive power prices, the estimated investment of 100 to 125 millions in feedwater heating equipment will conserve an expenditure of approximately 400 million dollars. These figures are far from visionary since a normal continuation in the growth of railway traffic will necessitate a corresponding increase in locomotive output.

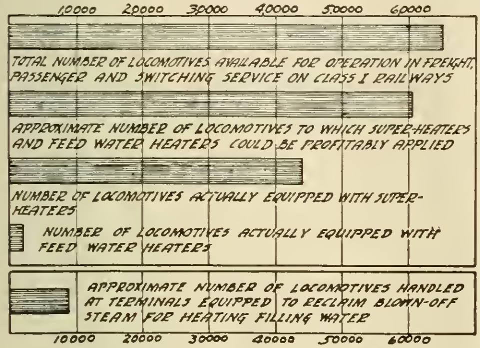


Chart Showing the Proportion of Locomotives Equipped with Superheaters and Feedwater Heaters

The largest factor for increasing locomotive output, however, may be anticipated in the form of facilities for increasing the percentage of time that locomotives are available for active service. This will come in the form of better equipment for maintaining motive power and turning it rapidly at terminals. Not to exceed 9,000 locomotives are now being operated through terminals having modern equipment for filling boilers with hot feedwater heated by blown-off steam. The installation of this type of feedwater heating equipment at all large locomotive terminals would add the equivalent of approximately 1,900 locomotives to the power available for service.

This enlargement in motive power capacity will be accompanied by a reduction in fuel consumption of corresponding proportions so that the outlook for locomotive feedwater heating is truly a great prospect.

Topics for General Foremen's Convention

The International Railway General Foreman's Association has appointed committees to report on the following topics at the annual convention in Chicago next September.

Automatic Train Control—Charles C. Kirkhuff, Atchison Topeka & Santa Fe, Chicago, chairman.

Supervision and Repairs of Special Appliances, Boosters, Reverse Gears, Feedwater Heaters, etc.—J. H. Armstrong, Atchison, Topeka & Santa Fe, Topeka, Kans., chairman.

Straight Line or Spot System of Car Repairs—G. P. Hoffman, Baltimore & Ohia, Baltimore, Md., chairman.

What Can the General Foreman Contribute to Obtain More Ton-Miles Per Shop Man-Hour?—F. B. Harmon, Atchison, Topeka & Santa Fe, San Bernardino, Cal., chairman.

Reclamation of Material, Car and Locomotive—A. J. Larrick, Baltimore & Ohio, Chillicothe, Ohio, chairman.

Best Routing System to Increase Shop Output—Wallace Murray, Chicago Rock Island & Pacific, Silvis, Ill., chairman.

Additional information may be obtained from the secretary-treasurer of the association, William Hall, Winona, Minn.

Report of Locomotive Inspection Bureau

The Bureau of Locomotive Inspection of the Interstate Commerce Commission inspected 6,298 locomotives during January, of which 3,054 were found defective and 354 were ordered out of service, according to commission's monthly report to Congress on the condition of railroad equipment. The Bureau of Safety during the month inspected 99,425 freight cars, of which 3,265 were found defective and 2,137 passenger cars, of which 24 were found defective. Thirteen cases involving 36 violations of the safety appliance acts were transmitted in January to various United States Attorneys for prosecution. During the year 1924, 31,446 locomotives were inspected, of which 14,617, or 46 per cent, were found defective.

An Estimate of Passenger Transportation by Busses

A statement by Edward F. Loomis, secretary of the national motor truck committee, National Automobile Chamber of Commerce, indicates that 12,500 busses and automobiles for bus use, were built and placed in service in the United States in the year 1924. This fact together with the estimate of 2,500,000,000 passengers carried in old and new busses in 1924, indicates the importance of the highway bus in our passenger transportation system. When added to busses in operation prior to 1924, these new vehicles bring the total number of busses in service in the United States and Canada on January 1, 1925, to 53,000. The gain during 1924 therefore represents approximately 25 per cent of the total now in use.

The figures and estimates by Mr. Loomis are based on a survey to which Bus Transportation, the American Electric Railway Association, the *Electric Railway Journal*, and the National Automobile Chamber of Commerce contributed. They show an approximate distribution of ownership as follows:

Common carrier independents	31,100
Electric railways	3,000
Hotels	1,000
Schools	15,000
Sightseeing, tourist and contract	1,500
Industrial use, including real estate, department store, apartment house, garage and factory service	1,075
Railroad terminal companies	250
Total	52,925

That electric railways realize the possibilities of the bus as a transportation medium is attested by the fact that while only 1,200 busses were used in this field on January 1, 1924, no less than 3,000 were used on January 1, 1925, representing an increase of 150 per cent. Three steam railroads are also operating busses in common carrier service through subsidiaries.

Woman Authorized Railway Director by the I. C. C.

The Interstate Commerce Commission has given permission to Helen L. Welsh, assistant secretary of the El Paso & Southwestern Ry. to serve as a director of the Southern Pacific Co., the Central Pacific R. R. This marks the first time the commission has ever granted this permission to a woman.

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The Economics of Feedwater Heating

In another column there is published an abstract of a paper on Locomotive Feedwater Heating by Mr. L. G. Plant of the National Boiler Washing Company, in which he assumes the same attitude of optimism as to the possibilities of future locomotive development that was taken at the recent locomotive symposium before the New York Railroad Club, and based, a part at least, of his prognostication on what the locomotive has done in the past. Of course it is acknowledged that there must have been a cause back of the great development of the locomotive during the past twenty-five years and it is here attributed to the growth of railway traffic and the necessity of meeting its demands. These requirements have been so well fulfilled that there has been the avoidance of the necessity of building 300,000 miles of main line track since 1900.

Mr. Plant reiterates what has, so frequently, been stated elsewhere in another way, that the improvements in the details of the machine and in the attached appliances of the locomotive, which have been advocated because of their money saving possibilities have not been utilized for that purpose, but rather to so increase the capacity or efficiency of the locomotive that more work has been obtained from the same type of equipment than was possible before, and, at the same time, there has been a reduction in the cost per unit of work done.

As for the heating of feedwater this is a solved problem so far as the technical details are concerned and it is now a matter of economics as to its further adoption, and these economics "are based on physical laws that are as old as creation and as fundamental to the locomotive as the generation of steam itself."

In order to emphasize this economic feature attention is called to the estimate that "approximately 20 per cent. of all locomotive fuel is consumed at terminals and that, in firing a locomotive by means of the shop blast, there is a steam consumption of 40 boiler horsepower per hour, and that by preheating the feedwater before kindling the fire about 1,200 pounds of coal can be saved.

All of which is about as eloquent a plea as can be offered for the practice which Mr. Plant advocates.

His picture of a fireless, smokeless roundhouse, where steam is generated from water heated by the waste steam of other locomotives, is a very attractive one, not only from the economic aspects but from that of the comfort and consequent efficiency of the men at work therein. This matter will be further dealt with in a future issue.

The estimate that an expenditure of from 110 to 125 million dollars in feedwater heaters will conserve the expenditure of about 400 million dollars for new locomotives is an attractive economic proposition and when we consider that the number of feedwater heaters in use has risen from seven to 2,400 within the past five years, the appearances are that its value is coming into a rapid appreciation.

Finally he shows that the use of a system of preheating the filling water for locomotive boilers, that is used after a washout will not only save fuel and time but will save labor as well, if steam is raised by the utilization of steam from the stationary plant. This can be made to operate automatically so that when once started it needs no further attention until it is time to disconnect the pipes and move the locomotive to the firing shed.

Here we have not only a saving in the cost of raising steam but a reduction of the locomotive time at terminals, an item that has vexed the operating department for many years. With these facts before us, there seems to be little doubt that the plea for a full extension of the adoption of the feedwater heater, provided water conditions will admit of it, and the use of a preheated filling water, has a sound basis to rest upon.

The St. Paul's Electrified Divisions as Compared with Steam Operation

President H. E. Byram has recently issued a most interesting and comprehensive report showing the comparative cost of electrical and steam operation on the Rocky Mountain, Missoula and Coast Divisions of the Chicago, Milwaukee & St. Paul Railway as of 1923.

There is a total of 25 pages of text, tables, charts, statistics, etc., including a map and profile of the lines from Harlowton, Mont., to Tacoma, Wash., which covers the electrified zones that total 650 miles (or about 6 per cent of their mileage), and is by far the most extensive operation of this kind ever undertaken, crossing as it does the mountain ranges in Montana, Idaho and Washington in its route from Chicago to the Pacific coast.

From its inception, this installation has been constantly under consideration by the leading engineers and transportation experts of the world, and since its completion it has been visited and studied by individuals and important committees not only from railways in the United States but most all foreign countries that are interested in transportation problems. It therefore follows that Mr. Byram's report, carefully prepared by statistical and technical experts, will furnish valuable information not heretofore available.

It is not our purpose to attempt an analysis of the great mass of data in this report, but to touch upon certain features in their relation to or bearing upon present conditions with respect to the St. Paul property as a whole.

This monograph shows clearly that electric operation on the district embraced is far more economical than steam power, the net total amount of saving over a period of nine years being $12,400,007, or an average of about $1,377,778 per year resulting from an expenditure or additional capital investment of $15,625,739, or about $24,039 per mile on 650 miles of line, for conversion from steam power to electric.

Aside from and in addition to the economies above shown, the writer can, as a result of having been over this line, riding on the electric locomotives handling trains so successfully over these heavy mountain grades, without the jars, jerks, impacts, smoke, noise, grinding brake shoes and hot wheels incident to and unavoidable with steam locomotives, certify to the highly satisfactory manner in which this St. Paul installation operates. To see and experience is to know whereof we speak, and any railway man who has wrestled with the intricate, expensive, and at times dangerous problems involved in moving trains up a mountain side against ruling grades of 1½ to as high as 3 per cent with steam power, and then by excessive wear, grinding or burning of brake shoes and wheels, and sometimes damage to engines, controlled these trains on the descending grades, could then witness the St. Paul's electric operation, and did not become enthused over it, is too dull of comprehension to be able to intelligently draw the line of demarcation in the most elementary problems of railway operation.

Legal and Financial Yard Stick

In the last analysis there are two standards or yard sticks to which all railway problems must conform to be accepted as satisfactory, namely, *legal* and *financial*, and as no legal questions are here involved we are only concerned in the financial or economic feature. This, we feel, should be reviewed from its inception and then given its broadest application as to present and possible future effect on the property, for there may be those who in the past, and even now, may have not clearly understood the economic value of electricity as a prime mover in the transportation field.

Electricity in Transportation

Following the first successfully operated street railway by electricity in this country, the engineers who had in the face of much opposition and no small amount of ridicule performed this great feat, were not only acclaimed as it were, but most all the former "doubting Thomases" experienced a change of heart overnight, but many of them were more extravagant in their prophecies for the future of electricity in the entire steam railway field than they had so recently been in their criticism and condemnation of those whom they termed "fools or cranks."

The press, particularly the technical branch, also joined the chorus of endorsement. One of our then leading railway presidents in an authorized interview predicted that in 25 to 30 years (from 1881) the steam locomotive would practically be extinct, except possibly a rare specimen here and there on some out of the way and out of date short line, and from that day to the present, with varying degrees of enthusiasm, in season and out, electrification of steam railways has been advocated and urged as a panacea or "cure all" for the economic ills from which they all have, and some still suffer.

When the foregoing "funeral arrangements" were tentatively mapped out for the steam locomotive, there were about 26,000 locomotives with an average tractive power of less than 25,000 lbs. while today we have about 67,000 steam locomotives with a combined tractive power of 2,576,641,000 lbs., while there is a total of about 400 electric locomotives.

Thus during this intervening period the steam locomotive has increased in number something like 150 per cent and in capacity about 296 per cent, while of the numerous railways that have struggled against the adverse conditions during the past two decades, there were only two that to any appreciable extent changed from steam power to electricity, and in each case it appears from the records that following the additional investment and with the completion and operation of what at that time was claimed would materially increase the prosperity of these companies that their financial difficulties seemed to *increase* rather than yield to the new order of things, and even now these lines do not seem to show any particular advantage over others in the same or similar territory that operate entirely with steam locomotives.

As the results from large capital expenditures in plant betterment, such as grade reduction, electrification, etc., should be evidenced by a proper return, and reflected in the relative value of securities, it might be of interest to compare the financial features of the St. Paul and its two neighbors and principal competitors, the latter having adhered to the steam locomotive as a prime mover.

From the foregoing it would appear to students of such problems that the two things of which the St. Paul were and have for some time been in greatest need and which are absolutely essential to their present and future welfare are:

(a) A very pronounced increase in volume of traffic, preferably high grade tonnage, so as to utilize more nearly up to its capacity their highly developed transportation unit. In other words, the plant is idle too much of the time and needs *more business* as the overhead and depreciation is going on all the time.

(b) Rearrangement of their financial structure, providing a substantial reduction in fixed charges.

The latter item seems quite important when considered in connection with the fact that in spite of economies effected of about $12,400,000 from electrification that the company's surplus has been reduced in the past five (5) years from $42,380,000 to $20,373,000 to meet deficits from operation, and that maturities to be met in the next 8 years total approximately $151,912,315.00 or an average of almost $19,000,000.00 per year.

The St. Paul is a splendid property and is ably managed by one of the best railway men in this country, but there is no man or set of men that can get more than about 100 cents out of a dollar, no matter whether he be farmer, banker, manufacturer, or railway executive.

Name of Company		Average price of stock & dividend rate, 1912 Aver. Price	Div. Rate	Average price of stock & dividend rate March, 1925 Price		Mileage Stocks and Bonds and Average per mile: Mileage	Stock and Bonds	Average per mile	Gross earnings 1923
Great Northern		$125	7%	$70	5%	8,254	$549,107,051	$66,526	$120,077,771
Northern Pacific		$125	7%	$70	5%	6,678	567,849,500	85,032	102,002,060
St. Paul	C-	$108	5%	$13	none	11,030	667,965,179	60,558	169,628,337
	P-	$140	7%	$22	none				
Average		$124		$44				70,705	

The Relation of Track to Stress

Indications That the Condition of the Track Has an Important Influence on the Intensity of the Lateral Stresses Imposed Upon It

By GEO. L. FOWLER

It is an old saying that "one swallow does not make a summer." While the saying may have the wisdom of our fathers back of it, it is equally true that while the one swallow may not make a summer, still the appearance of a single swallow is a presage that summer is not far away.

So the scanty data here presented cannot be taken as a demonstration that track condition is the prime or controlling element in the development of the stresses to which it is subjected, that data does indicate that the condition of the track has an important influence.

An article on Track and Tonnage which appeared in Railway & Locomotive Engineering for January, 1925, gave the results of track improvement in the increased possible tonnage of trains. A case where a change of track conditions was entirely responsible, as everything else remained the same. But while this may have improved the hauling capacity of the locomotives, there is nothing in connection with it to show or prove that the actual stresses between the wheel and the rail were either increased or diminished, and it is only when taken in connection with other facts that are to follow that we have the right to infer that such a decrease probably did occur.

It is almost axiomatic to say that track condition has an important influence on vertical stresses. Still it may be well to cite some available data, of which there is confessedly very little of a really quantitative character.

It is common practice to judge the surfacing of a track by the amplitude of the vibrations of the recording needle of a vibration recorder placed upon the floor of a car. The greater the vibration the rougher the track, and also the greater the vibration the greater the assumed intensity of the vertical stresses. An example of such a record is given in the two accompanying diagrams. In one the car was run over a branch line, where the track was not in good surface and in the other it was over a well-surfaced main line. The difference in the amplitude of the vibrations is some indication of the relative intensity of the stresses imposed, though far from an accurate measurement.

The same statement holds for the horizontal vibrations.

In both cases the car was the same and the only change was the condition of the track.

As for lateral stresses the available data indicates a close relationship between their intensity and the influence of track condition, though as to exactly what the condition must be in order to increase or decrease the lateral stress is not very well defined.

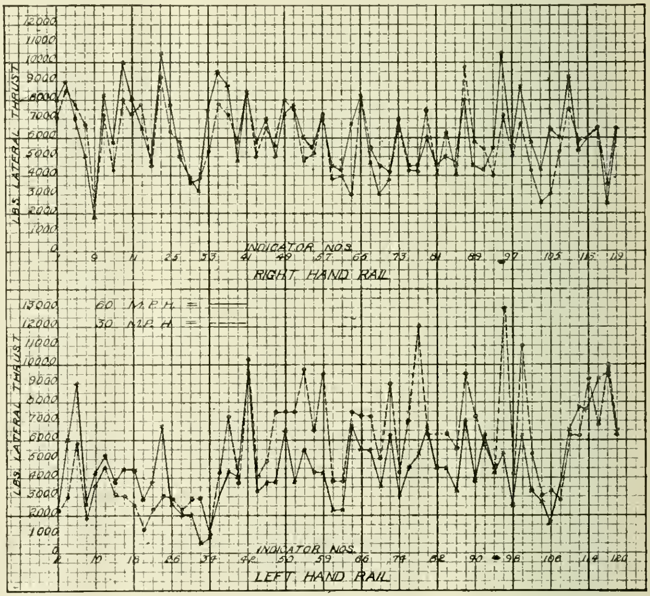
An investigation was made on a straight track on the Canadian Pacific some time ago in which for a distance covered by sixty ties, the amount of the lateral thrust on the rail at each end of each tie was recorded.

The track was laid on a fill about four feet high, the grade material having been deposited on a moskeg foundation that was very elastic. There was a distinct wave motion between the trucks whenever a train passed, which was not influenced, in any way, by the application or presence of the recording apparatus. The point to be borne in mind is that the track was very elastic and had considerable vertical motion under the passage of a train or locomotive.

Locomotives of various types were run, at different speeds, over this track.

It was found that regardless of type of locomotive or the speed at which it was run the heavy stresses were imposed on the same ties. To illustrate this a few diagrams are here presented.

In one the lateral thrusts imposed on the right and left hand rails by a Pacific locomotive, running at speeds of



Comparison of Lateral Thrust of Pacific Type Locomotive at 60 and 30 Miles Per Hour

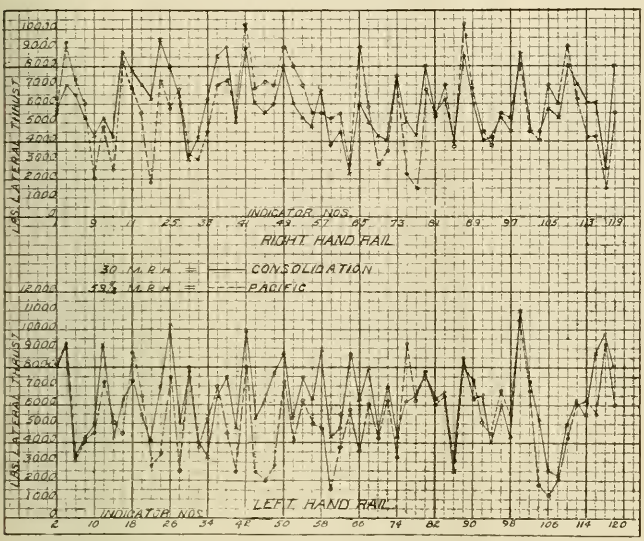
30 and 60 miles an hour are given in complete detail.

The indicator numbers are those of the instruments used, those on the right hand rail having been given the odd and those on the left hand rail the even numbers.

The dotted line indicates the thrusts at a speed of 30 and the full lines at a speed of 60 miles an hour. The uniformity of the rise and fall of these lines is remarkable. Not only do the ties on which the high pressures and low pressures severally occur coincide, but there is less variation in their intensities than would have been expected.

That the counter-balances and running gear of the engine should have occupied the same points relatively to the ties at these two speeds is inconceivable, for in order to attain the speeds recorded the locomotive was sent back two miles from the apparatus as a starting point for the sixty miles an hour record while a half mile served for the speed of thirty miles an hour.

A second diagram shows a comparison between the lateral thrusts imposed by a Pacific locomotive running at a speed of 59½ miles per hour and a consolidation at 30 miles per hour. And again there is an almost absolute coincidence of the high and low spots.



Comparison Lateral Thrusts of Pacific Type Locomotive at 59½ Miles Per Hour and Consolidation Type at 30 Miles Per Hour

Furthermore, if the high points of the two diagrams are checked one against the other, they will be found to be in very close agreement.

In short, this investigation seems to show that if the wheels of one engine place a high pressure upon the rail at any one point, then the wheels of all types of engines regardless of speed will place a high pressure upon the rail at that point. At least that holds for the particular track upon which these runs were made.

Unfortunately this peculiarity was not detected until the investigation was nearly completed so that little or nothing was done in order to ascertain what peculiarity of track condition was responsible for this unexpected result.

There was a very crude attempt made to measure the vertical movement of the rails, but the measurements must be considered as mere approximations.

The record of the average vertical rail movement at each tie for one series of runs is plotted against the average lateral pressures exerted by a Pacific locomotive making seven runs over the apparatus. There were two each at 40, 50 and 60 miles an hour and one at 30.

The vertical scale for the wheel pressures, indicated by a solid line, is expressed in lbs. of thrust, while that of the rail movement or deflection is expressed in thirty-seconds of an inch. It is to be understood, moreover, that this deflection is that of the rail relatively to the roadbed and not the total deflection, because, as already stated, the roadbed itself had an undulatory motion under the passage of the locomotive or trim.

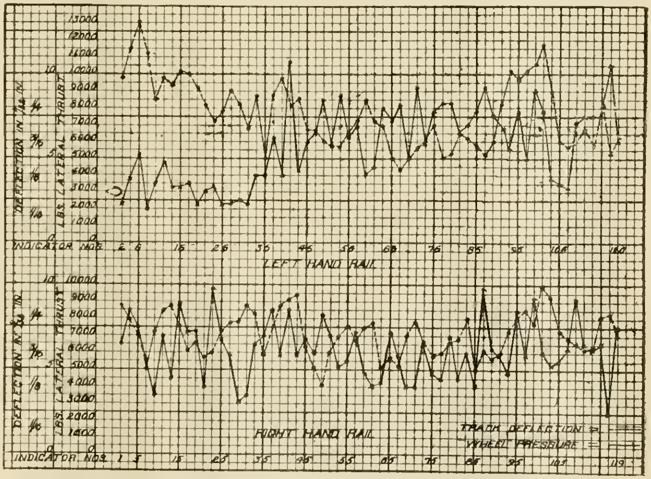
In this we find that there is little or no fixed relationship between the magnitude of the deflection and the rail pressures. So that insofar as these investigations are concerned we are left in the dark as to whether it is deflection or lack of deflection that increases or decreases the lateral pressure of the wheel on the rail.

Again in another investigation the same coincidence of maximum stresses appear. In this case the track was especially prepared for the tests. Steel ties were used to which the recording heads were applied and they were set in stone ballast which was lined and surfaced and the whole was in a very substantial condition, and there was no wave motion accompanying the passage of a locomotive that was perceptible to the eye.

Three records have been taken at haphazard from the many that were made and plotted in juxtaposition. These were the records of an eight-wheeler (4-4-0) at a speed of 85 miles per hour, and two of a ten-wheeler (4-6-0) at speeds of 27 and 18.2 miles per hour respectively.

While there is not the same close harmony of action that there was in the previous case, there is enough to indicate that track conditions had an influence upon the wheel pressures exerted upon the rail. In this case the reading is interpreted in terms of the depths of the depression made in a steel plate by a hardened steel ball.

In this case there was a greater harmony of action between the two speeds of the ten-wheeler than between the action of the ten-wheeler and that of the eight-wheeler. The lateral thrust of the latter being generally less in spite of its greater speed. Yet there was a decided co-



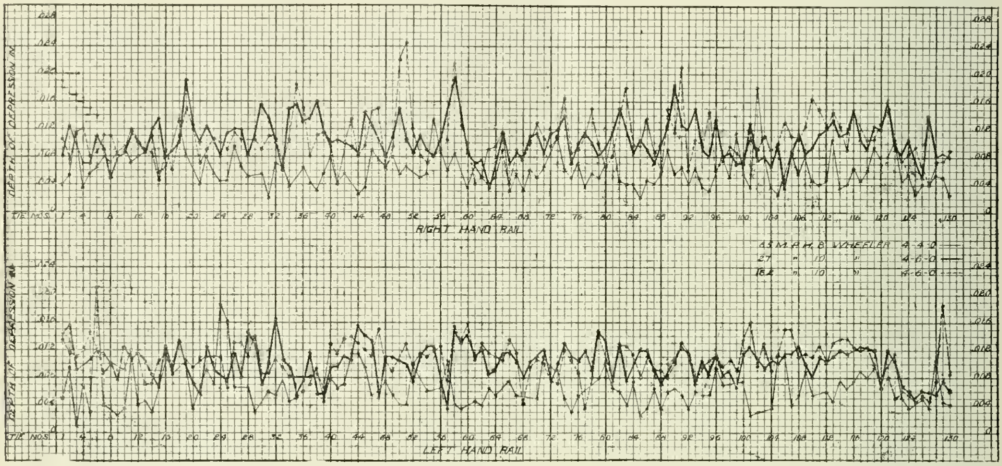
Relation of Lateral Thrust of Pacific Type Locomotive to Rail Movement incidence between the high and low spots of the two types of locomotives even when running on this track that was especially prepared to avoid track variation.

So much for indications obtained on a normal track. The results on a distorted track were more pronounced provided that the distortion was of the proper character. Where a short hump was put in one rail it produced no noticeable effect on the action of the locomotive, as the rise and fall was cared for by the springs, without moving the body of the vehicle itself. When this hump was lengthened, men on the engine could feel the rise, but there was no marked change in the intensity of the lateral blows delivered by the wheels upon the rails.

These last items, which are almost self evident in their results are quoted merely to emphasize the probability of track influence when in its normal condition.

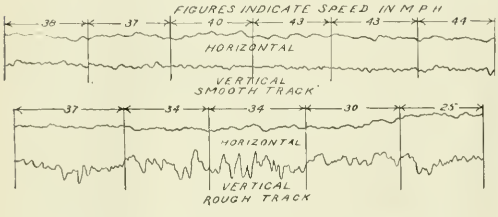
The conclusion reached after a consideration of these investigations is that the blow delivered or the stress imposed at any particular point of the track is dependent more on the condition of the roadbed than of the locomotive. This is shown by the marked similarity of the diagrams of any particular locomotive, from which it appears that the light and heavy blows are apt to occur at the same unit respectively, regardless of the speed at which the engine may be running.

As to just what that track condition must be in order



Comparison of Lateral Thrusts Imposed by Eight and Ten Wheeled Locomotives on a Stone-Ballasted, Especially Prepared Track

Two humps were then put in the rails, one in each, set diagonally from each other. This caused a material increase in the intensity of the lateral blows delivered against the rail. The next step was to place three diag-



Vibrations of Passenger Car on a Smooth and Rough Track

onal humps in the track; two in one rail and one in the other. This caused such an increase in the intensity of the lateral blows that when traversing the track at a speed of 45 miles per hour, the engine was rolling to such an extent and the lateral thrusts were so great, that it was considered inadvisable to run any faster or even to repeat the runs at that speed.

It was also found that if one rail of a straight track is made higher than the other, the locomotive will lay over against the low rail and the lateral stresses on both rails will be less than when they are on the same level.

Finally with a widened gauge the lateral stresses which a locomotive will put upon the track will be increased.

to cause a locomotive to deliver a heavy or light blow at any particular place cannot be stated from available data. Whether it is a rail movement or rail rigidity has not yet been determined, but from the checking of data procured under widely different conditions of track, it seems probable that these blows may be caused not so much by actual movement or lack of movement of the rail but by the relation of the rail movements to each other at two adjacent points. This, however, still partakes of the nature of a surmise. But the fact remains that the track condition is a most important factor in whatever may occur.

Cars on order number 59,295

Class I railroads on February 1 had 59,295 freight cars on order, by the carriers with the Car Service Division of the American Railway Association.

This compares with 55,684 on order on January 1 this year and 25,390 on order on February 1, 1924.

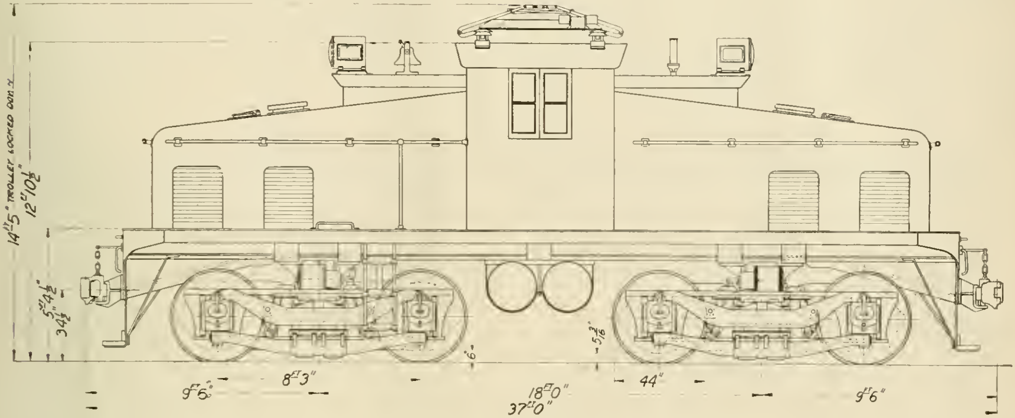
Of the total number on order on February 1 this year, box cars numbered 31,018, coal cars 22,111 and refrigerator cars 2,406.

During the month of January this year 12,735 freight cars were placed in service by the Class I railroads of which box cars totaled 6,367, coal cars 3,935 and refrigerator cars 1,272. In January 1924 a total of 16,192 freight cars were installed in service.

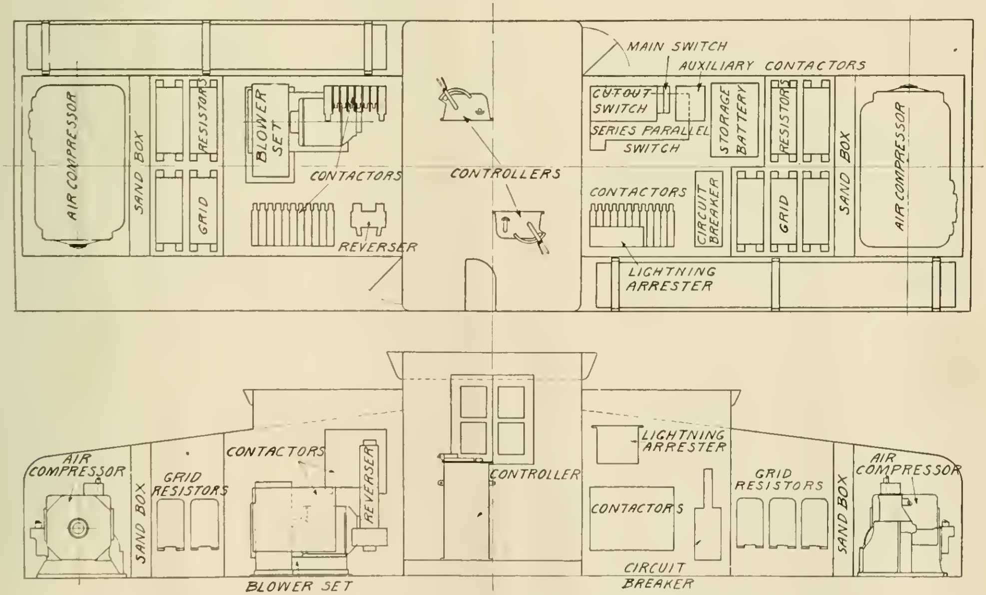
Reports also showed 167 locomotives placed in service during the month of January with 280 on order on February 1. During the month of January last year 271 locomotives were installed in service while there were 439 on order on February 1, 1924.

New York Central Railroad Electric Freight Locomotives

The New York Central Railroad Company has placed orders with the General Electric Company for seven 100-ton electric switching locomotives and two 170-ton electric road freight locomotives, to be put in service on the Electric Division at New York City and vicinity. These locomotives will be thoroughly tried out, in anticipation of the future electrification of the West Side freight tracks running from Spuyten Duyvil to Canal street in the city of New York. The locomotives, which are being built jointly by the General Electric Company and the American Locomotive Company, will be equipped for both third rail and overhead collection of current.



Side Elevation of New York Central Railroad 100-Ton Electric Switching Locomotives



Arrangement of Apparatus on New York Central Railroad 100-Ton Electric Switching Locomotives

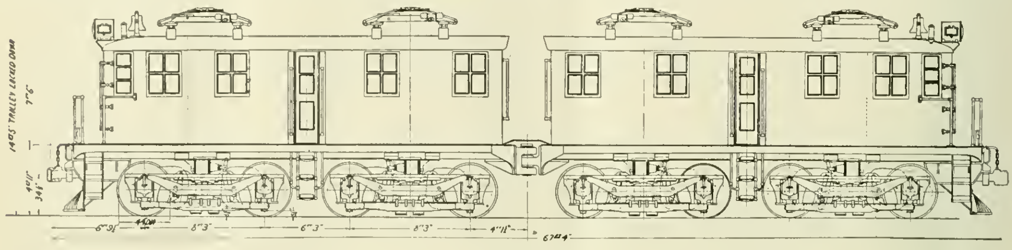
The specification for the switching locomotives provide for handling a 1,500-ton trailing train, consisting of 75 per cent empties and the balance of loaded cars, at a speed of not less than 25 miles per hour. The road locomotives will handle a 3,000-ton train of the same general make-up, at speeds not less than 32 miles an hour.

The switching locomotives are of the steeple cab type, carrying two swivel, equalized trucks equipped with four 600 volt motors. The outline of the locomotive is shown in one of the illustrations and the general arrangement of the apparatus in the cab in the other. The nominal continuous rating of these locomotives is 1,240 horsepower, or approximately 310 horsepower per motor. A gear ratio of 72 to 17 is used with the cushion type gear. This has given satisfactory service on the Paulista locomotives, and is being used with similar success on the Mexican Railway Company's locomotives.

The cab platform consists of an integral steel casting to insure ample strength for this character of service. A master controller is provided at the engineer's position on each side of the cab, and the control and auxiliary apparatus is installed in the sloping end cabs.

The control is Type PCL, operating from a 32-volt storage battery. The 32-volt supply, in addition to operating all control circuits, is also used for cab lighting and for headlights. The type of control eliminates high voltage from the master controller and employs electro-pneumatic contactors located in the end cabs for operating the main circuits. Remote control is used for all accessories, including blower motor circuit, compressors, reversers, etc. Protection against overload or short circuit is obtained by a high speed circuit breaker connected in the high side of the main supply. An additional protection against injury to the individual motors is provided by overload relays in each motor circuit. These are so arranged that a short circuit on an individual motor will trip out the high speed breaker. The battery is charged by being connected in series with the blower motor. To protect against over-charging, a by-pass resistance is used in parallel with the battery thus reducing the charging current. The use of this resistance is controlled by an ampere-hour meter.

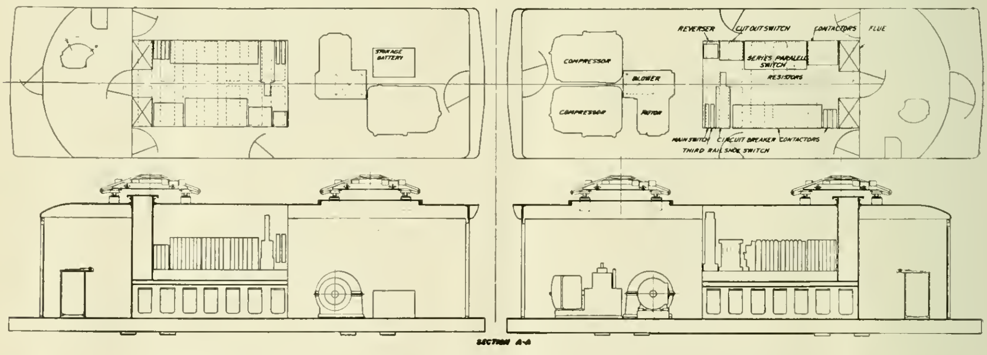
The master controller is of the standard design, using three handles—the main operating handle, a reversing handle, and a reduced field handle. Three full running speeds are provided, with the motors in series, series parallel and full parallel. In addition, two reduced field steps may be used with each motor arrangement, giving a total of nine free running speeds. Two compressors provide a total of 200 cubic feet displacement at 130 pounds pressure for the air brakes. Other accessories include a motor-driven blower located in the end cab for ventilating the traction motors, a bell and whistle mounted on the roof, and suitable equipment of air-operated sanders.



Side Elevation of New York Central Railroad 170-Ton Freight Locomotives

Road-Freight Locomotives

The running gear for the freight locomotives is similar to two switching locomotives coupled by an articulated joint, and the motor and control equipment duplicates those used on the switchers. The out line of this locomotive is also shown in the drawings as is the arrangement of the apparatus in the cabs. A gear ratio of 69 to 20, however, is used, giving a higher running speed and permitting a maximum speed of 60 miles per hour. Two box type cabs are provided. These are carried on cast platforms similar to those used in the switchers. Two compressors, giving a total displacement of 300 cubic feet of free air at 130 pounds pressure, will be installed. The box cabs will be somewhat similar in appearance to the present passenger locomotives, having rounded ends of the same general character. A high speed circuit breaker will be installed in each cab, protecting each half unit independent of the other. The pantographs are of the hornless design, operating through a range of 25 inches. Two of these are mounted on each cab. In order to operate over the present Electric Division and such portion of the West Side tracks as will be equipped with third rail, shoes are provided on both sides of each truck.



Arrangement of Apparatus on New York Central Railroad 170-Ton Electric Freight Locomotives

One of the novel details is the provision of forced grease lubrication for the pins in the spring rigging. A bell and whistle are also provided on each cab. All locomotives will be equipped with solid rolled steel wheels, in accordance with the railroad company's specifications.

Provision is also made for a complete set of tests, to be made by the General Electric Company and the New York Central Railroad jointly, after these locomotives have been delivered to the electric division, when details of their performance will be published in the pages of this magazine.

The principal features of these two locomotives are as follows:

	Road	Switcher
Length	67 ft. 4 in.	37 ft. 0 in.
Height (over trolley locked down)	14 ft. 5 in.	14 ft. 5 in.
Wheel base	53 ft. 9 in.	26 ft. 3 in.
Rigid wheel base	8 ft. 3 in.	8 ft. 3 in.
Maximum emergency, m.p.h.	60	60
Gauge	4 ft. 8½ in.	4 ft. 8½ in.

Analyzing Shop Output and Costs

A Paper Read Before the New England Railroad Club

By J. E. Slater, Assistant to General Manager, New York, New Haven & Hartford Railroad

Before discussing methods of statistical analysis, one should inquire whether any method of analyzing shop output and costs is, in fact, necessary. A large number undoubtedly will answer in the negative. That same answer has been made by many transportation officers as well, but such a statement is based upon a hope rather than upon a fact.

I have in mind several years ago a study which was made of a particular phase of engine house operation in which a very large amount of overtime was being earned. The mere figures in themselves were so conclusive that the overtime was eliminated immediately the information was in the hands of the officer in question. Although he had observed that operation at that particular point many times before, and though it was under the constant view of his subordinates, it had never occurred to any of them that such a saving was possible.

For the railroads of the United States, the ratio of maintenance of way expenses to operating revenues in 1913 was 13.1 per cent; in 1923, it was 12.9 per cent. In the same period, the ratio of transportation expenses to operating revenues increased from 34.4 to 36.9. On the other hand, the maintenance of equipment ratio increased from 16.1 per cent to 23.4 per cent. These figures in themselves do not signify that there has been an excessive increase in maintenance of equipment expenses. Nevertheless, they put the question squarely to the mechanical officers to justify the startling differences. While there is no doubt that the increase in the size of the locomotive, in the number of appliances and the increase in the intensity of the work are important factors, it is impossible to judge accurately to what extent the greater increase in mechanical expenses is due to these factors. With the scanty amount of information available, it is difficult to tell anything about our maintenance of equipment expenses. Is it not common sense to attempt to analyze these expenses before we condemn entirely the use of statistics in mechanical operations?

Yet we do have some mechanical statistics. Whether he desires it or not, the mechanical officer will be checked by the data available. That data should be informative. Today it is not. Let us then analyze the statistics which are available and determine to what extent they give accurate information and whether it is possible to make such changes that a proper analysis can be made.

The Weakness of Locomotive Repair Classifications

The statistics of output of our locomotive shops are confined for the most part to the number of engines turned out. The classification of locomotive repairs adopted by the United States Railway Administration has been continued, not apparently because it has any intrinsic merit, but because no better classification has been suggested.

While by this classification it is intended that heavy classes of repairs should mean heavy work for the entire locomotive and lighter classes of repairs should cover light repairs for all parts of the locomotive, as a practical matter the classification is largely controlled by the boiler and firebox work and the turning of tires. The work on machinery and tender is not controlling. Furthermore, the classifications are so broad that in themselves they give little idea as to the amount of work which has been done. If an engine house turns a set of tires and does the necessary work on the machinery and boiler, it is given credit for a Class 5 repair. If, in a shop, the flues are not installed new or re-set but very heavy repairs are made on the machinery, possibly involving new cylinders, extensive rod work, etc., it received credit only for a Class 5 repair.

In connection with the Class 3 repair there may be nothing done on the boiler, but the installation of a new set of flues; yet, the same credit is allowed as when a new set of flues is installed and the firebox largely renewed. Every mechanical man recalls numerous cases of Class 5 repairs costing more than Class 3 repairs, and one Class 3 repair costing twice as much as another at the same shop and for the same class of locomotive.

Frequently attempts are made to equate classes of repair to standard units. A Class 1 repair is assumed to have three times the weight of a Class 5 repair, a Class 2, two and one-half times, etc., the total output being expressed in equated Class 5 repairs. I have tried to do this myself and at last have arrived at the conclusion that such a method is not worth the time taken to perform the work. An example of the uselessness of such attempts came to my attention very recently. A statement was prepared analyzing the costs of classified repairs at one of our shops. The classified repairs were equated to Class 5 repairs and a cost per unit obtained for each month of the year. Using the first month as a base, and comparing the results of the other months with it, it was found that the costs for the later months were consistently lower than the costs for the first months. The saving for the eleven months was found to be in the vicinity of $300,000. The statement was given me to check. We set up another statement using the last six months of 1923 as a base instead of January, 1924. The method of equating was slightly different but based upon the actual differences in the cost of the various classes of repair during the year 1924. This statement indicated that instead of there being a saving of $300,000 there was a loss of approximately $350,000. Which of the statements is correct, neither I nor anyone can tell.

In spite of the well recognized fact that the present classification furnishes little information as to the work done, it is universally used and is one of the few statistics which we have today governing our locomotive maintenance program. It is an excellent example of the weakness of our present mechanical statistics, for it provides just enough information to provoke questions, while it answers few of them.

There are two ways by which the statistics of output of locomotive shops can be improved, either one of which is a distinct step in advance of the present method. The first method is that of breaking up the two largest and most important classes, namely, Classes 3 and 5, into sub-groups in accordance with the character and amount of boiler and machinery work done. A segregation made by one of the New Haven staff contemplates six sub-classes under Class 3 and four under Class 5. For the Class 3 repair, boiler work is divided into three sub-classes and the machinery into three sub-classes. The heaviest boiler work would involve the renewal of sections of a firebox, such as a half or quarter of a side sheet, door sheet or throat sheet. The medium class of boiler work would involve patching rather than renewals. Under the light boiler work there would be no firebox work.

Under the heavy machinery work there would be involved new cylinders, pistons, guides, valves, crossheads, on valve motion, as well as other heavy work on rods, shoes and wedges, driving boxes, etc. This would be work involved primarily in the superheating of engines formerly using saturated steam. The medium class of repair would include heavy machinery work on locomotives not being super-heated, involving a new cylinder or cylinders re-bored and re-bushed, frames rebolted and work of the same class on shoes and wedges, driving boxes, rods, etc. The light class of repair would involve no new cylinders, but only the necessary work in building up, facing, grinding or aligning cylinders, pistons, valves, guides, crossheads, rods, etc.

In Class 5, the boiler work and the machinery work are each divided into two classes—heavy and light. The heavy boiler work involves patching the firebox, while in the light class of repair, no patching is required, but only the necessary renewal of stay bolts and other work following the test. Under the heavy machinery work there would be new cylinders or cylinders re-rebored and faced, together with piston heads built up, rods ground and guides either new or built up. It also involves the overhauling of the valve motion and crossheads babbitted and planed. Under the lighter class of repair, there would be no work on the cylinder and only necessary work on rings, guides, rods, valve motion, etc.

Whether it is necessary to divide Class 3 repairs into six groups and Class 5 into four groups or not, the tremendous range in the average cost of these repairs makes it obvious that some natural sub-divisions can be made. Such sub-divisions would indicate clearly the causes for differences in the cost of making classified repairs and would tend to cut down to a very large extent the differences in the cost per engine. With the additional information as to the character of boiler and machinery work, many questions would be answered on the face of the report. This particular method also has the advantage of using the present classification of locomotive repairs and the information can be developed from the data on the shop report. It is possible if comparisons are desired, to go back and work it up for past periods.

The second method is that of equating the classified repairs on the basis of standard hours. The standard man-hours would represent the total hours under bonus or piece work schedules necessary for the work. For example, let us suppose that the standard hours of an ordinary or normal Class 3 repair is 4,000. Let us then assume that the standard hours of an actual Class 3 repair is 4,400. The output would be increased not by one Class 3 repair, but by 1.1 Class 3 repairs. Likewise, if the standard hours of an actual job amounted to but 3,600 hours, the output would be increased by only .9 Class 3 repair. In this manner, since the standard hours are an absolute and unchanging measuring stick and are not affected by any difference in the efficiency of the men, there is provided an absolute method of equating the differences in the amount of work done in different locomotives. In days gone by, classifications were frequently based upon the amount of money or man-hours actually spent. The objection to this basis, however, is in the fact that the more inefficient the men and supervision of the shop, the heavier the class of repair as shown by the report. When the work is expressed in standard hours, however, there is furnished an equation factor unaffected by the efficiency of the men, changes in wage rates or other like items.

This method, however, is possible of application only where there is some cost time keeping or bonus system, and where the operations are currently tabulated and the standard hours applied to them. Fundamentally, it would be possible to obtain the information where piece work systems are used, but the piece work system in itself does not necessitate the compilation of what the man does coupled with the length of time taken to do it. Under a bonus or a cost time keeping system, such information must be compiled in any event so that it is available for other use without greatly increased clerical work. Such a basis is not susceptible of universal application. The standards would necessarily differ with different shops. This, in itself, however, should not be a determining factor since it is generally recognized that it is impossible to make comparisons between shops on any but the broadest lines, and such comparisons are usually fruitless.

One of the greatest defects in our present accounting system as far as maintenance of equipment expenses are concerned, is in the combination of classified and running repairs in one account. One of the first segregations which any road should make in its Account 308, Locomotive Repairs, is a division between classified and running repairs. These two groups of expenses are controlled by different sets of circumstances. For the most part, one is performed at the shops and the other at engine houses. One is governed largely by the mileage over a period of many months—the other by current mileage. One is primarily on a production basis—the other on an emergency basis. One should be measured by the amount of work put on the engine, while the other can be measured by current locomotive miles or other like units.

The second sub-division should be between types of locomotives. This information is valuable, not only because the cost of maintenance will naturally vary with the weight, size and class of service in which the engine is engaged, but is also valuable to the management in its consideration of future purchases of power. Everyone knows that the maintenance cost per locomotive mile or per 1,000 ton-miles of different types of locomotives of approximately the same tractive force will vary considerably, and it is highly important that the maintenance costs should be on such accurate basis that the management can take these facts into account when purchasing new engines.

In the division of the repair costs among the classes of locomotives, and particularly when this is carried to a cost for each locomotive repaired, it is of the utmost importance that the assignment should be as complete and accurate as possible. All mechanical men are familiar with the division of expenses that was obtained under the old system in which the men designate the number of hours spent on each engine. On almost every railroad there are classic examples of large amounts being charged to an engine which had not for a long period of time turned a wheel or which had been stored. On the other hand, when an accurate allocation of expenses is desired, there is a great difficulty in assigning all of the expenses or even a large portion to individual engines. If a knowledge of the cost of repairing the individual engines in a shop is of any value whatsoever, it is worth while to have the clerical work in preparing these data made important and not incidental.

Car Repair Costs

I believe it will be found that better records will be obtained where the accounting work is done under the jurisdiction of the accounting department by a shop accountant stationed at the shop than when it is done by clerks on the mechanical department payroll. When the accounting is done by the mechanical department employees, adequate supervision is rarely given it since the work is not the fundamental job of the mechanical department. On the other hand, it is the principal task of the accounting department to obtain accurate and complete records. Experienced supervision is provided to see that the records and reports are correct. New methods of doing the work are studied and applied. It has been our experience that with the accounting work done by the accounting department better results are obtained.

I would go further, in dividing the cost of locomotive repairs and would so segregate them that I would know the cost of the maintenance or renewals of various parts of the engine. The boiler would be divided as to shell, firebox, tubes and other parts; the machinery as to running gear, valve motion, frames, cylinders, rods, spring rigging, foundation brake rigging, engine and trailer trucks, cabs, boiler fittings, steam pipes, throttles, etc., air brake equipment and miscellaneous; the tender as to cistern, underframe and trucks. In addition, there would be separate costs for the unwheeling and stripping of the engine and the final painting.

With this information, and with further segregations which can be made when desired, it would be possible not only to analyze to a better degree the cost of individual repair jobs but to have available accurate information as to various types of parts. The officers' data are based only on observation and such information as may be derived from checking the issues from the stores department over a period of years. On the New Haven this will not require any appreciable increase in accounting expense, most of the data being available now from the bonus record, the only additional work being in adding several columns instead of one or two.

Here, as in answer to many other questions on mechanical costs, I would say that since we have practically no information now, we can not say that such additional information will not be worth the expense of compiling it. In view of the enormous expenditures for locomotive maintenance, we should make the attempt before we condemn in wholesale fashion any method of analyzing expenses more accurately.

Checking Unassigned Expenses

We usually think of costs in our own shops in terms of labor and material, and I fear that very frequently the items of unassigned and shop expense are not analyzed. I question whether it is necessary to make any detained analysis of these items currently since they will be controlled to a large extent by the amount of production at the shop. Nevertheless, in view of the fact that shop expense will amount to 25 or 30 per cent of the cost of assigned labor and the unassigned expense at some points is very large, we should at least once or twice a year have a complete segregation of these items and an analysis made of them.

In addition to shop expense, there is the question of the use of machinery. Large locomotive shops are filled with expensive machinery and there should be some effort to determine whether the purchase of machinery has been justified. This should be done not as a post mortem examination, but as an aid in the purchase of future machinery and also with a view of re-locating machinery in that or some other shop where it can be used more intensively. At commercial shops where cost accounting systems are employed, overhead is charged for the machine and the space it occupies on the basis of the time in use. No such system is necessary in a railroad shop, but I see no reason why a time study can not be made periodically to determine the number of times machines are used and the cost in fixed charges per operation.

It has been my observation that we are likely to go to either of two extremes—either we assume that we can make any item of material cheaper than we can buy it, or we assume that we can make nothing as cheaply as we can buy it. The best way of deciding this point accurately is to test out the proposition and take into account the fixed charges per operation on the machines used. This will provide many surprises where there are expensive machines without intensive use of them.

Locomotive Performance Related to Repair Costs

There is one other way of checking shop costs: by the performance of the locomotives after they have come from the shop. It is a general practice to assign a locomotive an anticipated mileage up to the next shopping and a comparison made of the actual mileage with the anticipated mileage. There are many other ways and means, however, by which the shopwork can be checked. We have found it exceedingly interesting to keep a chart showing by individual locomotives the number of days out of service and the days when there were failures. Poor shop performance is frequently brought out by the large number of days that the engine is out of service for running repairs and an analysis of the cause of the detention for running repairs will indicate wherein the shop failed to do its work properly. From the standpoint of general performance of all locomotives turned out of the shop, it will be found of interest to compare the shop costs in various periods with the performance in the various classes of service. For example, the freight locomotives can be checked on the basis of the gross ton-miles per train hour, the miles per locomotive day, the locomotive miles between shoppings, the fuel consumption per 1,000 gross ton-miles and the locomotive miles per failure. The passenger locomotive can be checked by the per cent of passenger trains on time, average miles per locomotive per day, miles between shoppings, pounds of coal per passenger car mile and miles per locomotive failure. The switching engines can be checked by the miles per day, the miles per failure, the miles between shopping and the pounds of coal per switching locomotive mile. In other words, in any analysis of shop costs from a standpoint of management, we should not confine our attention to the cost per locomotive, but must go further and compare these costs per unit of output with the performance of the engines after they have been turned out. The output may decrease and the cost per unit of output increase, but this may be due to improved standards of maintenance and to more rigid inspection, which, in turn, will result in a far better performance after the engines have been put in service. This has been the actual situation on more than one railroad under my observation.

In the case of passenger car repairs, there is no set rule as to the classification of output. At the present time, on the New Haven passenger car repairs are divided into two main classes—general and minor. In a general repair the paint is burned off; in a minor repair it is not. While it may be true that the heaviest expense in connection with the ordinary repairs to steel passenger cars is in the painting, such a segregation is of little value where there is a consistent program of installing steel underframes or re-building trucks on wooden cars or making extensive renewals of plates on steel cars. In other words, this segregation may be a fairly reasonable one for the New of comparatively new steel cars and where there is relatively less work being done on wooden cars.

When the steel cars are older and there must be extensive repairs to the side plates on account of rusting around window sills, eaves, etc., the present classification will be comparatively worthless. On another railroad we found a dining car which was substantially re-built costing $25,-000. This job, under our classification, would be placed in the same class as a coach on which the ordinary general repair work was done, costing about one-sixth as much.

Passenger Car Repair Output

The standard hour can be used here to excellent advantage. It provides an accurate measuring stick of just what work was put on the car, not on the basis of the time actually spent, but upon a standard time for doing that work. With a standard time, the same performance each time is given the same credit and the sum total of the operations can be expressed in the common unit of standard hours. If it is desired to maintain the present classes such as the division of the Boston & Maine repairs into five classes and the New Haven's into two, the output can be expressed in ratios of a general repair or a minor repair as measured by the relationship of the standard hours of each actual job to the average or normal standard hours for doing the ordinary amount of work for that class.

As to the costs of repairing passenger cars there is almost a complete lack of information. Frequently, not even the costs of repairing individual units or classes of equipment are kept. Such was the situation on the New Haven until fairly recently when a system was instituted by which the cost of repairing passenger cars was kept separately for each unit repaired. These units are then combined into classes so that we receive monthly report showing the cost per car for general and minor repairs divided as between steel and wooden cars and divided among the various classes—coach, baggage, combination, main, milk, etc. These figures in themselves are extremely valuable. We have gone further than this, however, and have sub-divided the car so that we will obtain currently the information for the following sub-groupings: Scrubbing, trucks, platform, electrical work, inside carpenter work, outside carpenter work, tinsmith work, pipe work, painting, buffing, upholstering, and trimming.

With such sub-divisions it is possible to determine and check separately the operations of the various departments, and by applying the standard hours for the various operations we are able to tell the efficiency of the various departments. Where work is delayed in the shop or where the cost is too high, it is possible to tell readily and quickly where the weakness lies.

Freight Car Repair Output

What I have said with reference to passenger car repairs applies equally to freight car repairs. As far as the output is concerned, there has been a tendency toward greater uniformity. The classes of freight car repairs are, for the most part, based upon the number of man-hours for doing the work. On the Boston & Maine a general repair must take 200 man-hours or over; a heavy repair from 20 to 199 man-hours, and a light repair from 1 to 19 man-hours. On the New Haven a Class 1 repair is anything in excess of 175 man-hours; a Class 2 repair 73 to 175 man-hours; a Class 3 repair from 37 to 72 man-hours; a Class 4 from 21 to 36 man-hours and a Class 5 repair under 20 man-hours. As far as the general subdivision between heavy and light is concerned, the New Haven and the Boston & Maine are on the same basis. The objection to the man-hour basis of subdividing freight car repairs is the same as that applying to the classification of passenger car or locomotive repairs in accordance with money spent. The greater the efficiency of the force, the less credit is given in the way of units of output. This objection could readily be removed, if, instead of the actual hours, the standard hours were used. The objection to the actual hours is well shown by an example in a shop on the New Haven. When the bonus system of payment was introduced in this shop, the efficiency of the force gradually increased. With the additional compensation and the realization on the part of the men that they would receive as much in increased earnings as their efficiency permitted, the performance improved more. Almost all of the work being done at this shop was re-building of steel coal cars, a Class 1 repair. Yet, because most of the work was being done in less than 175 man-hours, this shop was being credited with a large number of Class 2 repairs, simply because the efficiency of the force had increased to that extent. If the standard hours had been used in this case, there would have been no different on account of the increase in the efficiency of the force and the number of units of output would have been the same in the later as in the earlier period. It is not, however, necessary to use the standard hour where the data are not available from which standard hours can be compiled. The important classes of freight car repairs can be sub-divided just as in the case of locomotives and the classification made to depend upon the extent of the renewals of floor, sides, roof, sills, trucks,

From the standpoint of costs, we should have for freight car repairs either the cost of the individual jobs or the cost by classes of cars. On the New Haven we receive monthly the costs of heavy reapirs to box cars, coal cars, flat cars and refrigerator cars. In addition, as in the case of passenger cars and locomotives, we are arranging to obtain the information as to the cost of repairing the different parts of the car. In this case, the sub-divisions are as follows: Stripping, jacking up, trucks, under-frame, draft gear and couplers, stringers and flooring, framing, inside lining, outside sheathing, roofing, door track and doors, brake and pipe work, safety appliances and painting and stenciling.

In this way it is possible not only to keep track of the cost of doing the various kinds of work, but by a comparison of the standard hours, it is possible to tell the relative efficiency of various groups of men doing the different kinds of work.

It is quite likely, as I have enumerated at great length the various reports and kinds of information which seem to me to be of value to the mechanical officer, I have given you the impression that he should be spending most of his time analyzing reports rather than observing the work being done. Elaborate reports are not valuable. The fewer the reports and the more simple they are, the better, but if we are to have any reports at all (and it is obvious that we must have some), those reports should be sufficiently comprehensive and accurate that they will be informative rather than provocative. They should give information rather than suggest questions. All of the information which I have suggested need not be used, nor need all of it be sent to all officers. It is obvious that the amount of information needed by the mechanical superintendent need not be as detailed as that made available to the shop superintendent, and the information for the general manager or other executive officers should be in considerable less detail than that available for the mechanical superintendent. If, however, the reports are outlined properly, the same basic data can be used for them all, the amount of detail being less for each grade of officer receiving any information as to shop output and costs.

It is not necessary to check each kind of operation each day, week or month. The system of sampling and of analyzing cross sections of the work is being found more and more useful and satisfactory. We are using it in transportation statistics where there is also an immense mass of information. Different phases of operations can be checked in a general way each month and a detailed analysis made once in several months. In this way, it is possible to use the immense mass of mechanical statistics by having a few simple reports currently and by making detailed analysis periodically. For example, in checking the output of a locomotive shop, we could have our cost per unit of repair by classes of locomotives and by classes of work, together with the utput, expressed in number of units equated on the basis of standard repairs or the number of classified repairs subdivided into 15 rather than 5 classes. This information would not take long to analyze currently. Then periodically we could analyze the cost in detail of the boiler work, or the valve motion work, the tender work, rods, etc. Occasionally we could test out the cost of maintenance of different types of parts about which more information is needed. On this basis the amount of time necessary for the analysis would not be great and this fund of valuable information could be used.

We should not assume that our costs are low and our performance excellent simply because no one can prove that they are not, and because it may require intensive analysis and considerable expense to obtain accurate facts as to the efficiency of our mechanical performance, we should not assume that it is worthless to assume the expense until we have made the effort.

Where Railroad Billions Go

President Crowley of the New York Central Gives Some Curious Facts About Railroad Expenses

In an address before the Pittsburgh Traffic Club, P. E. Crowley, President of the New York Central Lines, told some curious things about railroad expenses, from which the following is extracted:

"The public has heard in the past a great deal about what the railroads take in but not enough about what the railroads pay out, with the result that in some quarters there is, perhaps, an impression that money once paid into a railroad till stays there and is lost to the world. The more than six billion dollars which the railroads received in 1923, and the lesser sum which they received in 1924, hesitated in the treasuries of the carriers hardly long enough to be counted before they hurried out again to help turn the wheels of industry and commerce and to support the life of the country. Very few of these busy dollars gravitated to the stockholders, to the owners of the railroads. As a matter of fact the carriers as a whole have been unable to earn the amount prescribed by the Interstate Commerce Commission as a fair return on the value of property devoted to public service under the Transportation Act of 1920. Furthermore, something more than one-third of the railroad mileage of the United States has never been able to earn any dividends whatever.

"In studying the division of the railroad dollar let us begin with wages, since they have a first claim upon receipts. Twice a month the great family of railroad employes receive their portion of revenues. In 1916 this portion amounted to substantially 41 per cent of total operating revenues. In 1923 aggregate compensation of employes called for nearly 48 per cent of total operating revenues. If you would realize how widespread this distribution is remember that one person in each 25 gainfully employed is carried on the railroad pay-roll. Of the aggregate amount collected by Class I railroads from the public in 1923 more than three billion dollars was disbursed in semimonthly installments on pay-roll account. Some part of this huge sum went into savings banks, building and loan associations, and other forms of investment: but the greater part was at once distributed through the channels of trade. Either through investment or in payment of current living expenses all of it was kept busy. Not a dollar was permitted to idle its time away in an unproductive till.

"Having provided for the pay-roll the railroads have left of the average dollar received a fraction more than 52 cents. From this must be deducted about 8½ cents to pay for locomotive fuel. In 1923 this included $455,000,000 for soft coal. Now, since the railroads consumed 28 per cent of all soft coal mined, it follows that the equivalent of 28 per cent of the entire number of bituminous coal miners are as directly dependent upon the railroads for a living as if their names were carried on a railroad pay-roll. The equivalent of 205,000 coal miners with their families look to the railroad as their only visible means of support. Equally dependent upon the railroads for their daily bread are the 219,000 workers required to produce the 30 per cent of iron and steel consumed by the railroads. These workmen and their families are exclusively supported by money collected from the public in freight charges and passenger fares. In the same way approximately 127,000 men are, in effect, employed and paid by the railroads to produce the 25 per cent of the National output of lumber which the carriers annually require.

"We must include in the list of those who are exclusively supported by the money received for freight charges and fares the employes of car and locomotive works to the number of 70,000. These workers constitute an important division of the railroad army, although their names do not appear on the railroad pay-roll, for the quantity of cars and locomotives required is enormous. In the last two years alone the railroads of the United States have purchased locomotives and cars of the aggregate value of $1,195,220,000, or more than one-sixth of the gross receipts of the carriers in 1923, the heaviest traffic year in history.

"If we add together the various classes of workers I have enumerated which are wholly supported by the railroads though not actually on the pay-roll, we have an army of 621,000 workers. Multiply this number by 4.3, the average number of persons per family according to the census of 1920 and we have a population of 2,672,000. Add railroad employes and their families calculated on the same basis and we find that about one-tenth of the population is included in these categories which are exclusively supported on the money which the railroads collect from the public. In addition to the few major items already enumerated the railroads also consume 10 per cent of all the copper and brass and varying proportions of an astonishingly along list of other articles.

"Just to give you some idea of railroad requirements let me say that the Manager of Purchases and Stores of the New York Central Lines is obliged to keep constantly on hand a stock of supplies which at any given time would inventory approximately fifty-seven million dollars. No fewer than eighty thousand separate items are included in this stock.

"Perhaps a few details about the curious variety of railroad supplies may be of interest. Take horses, for instance. The manager of purchases is obliged to understand the good points about a horse in order that he may expend company funds wisely. He must be informed about automobiles, for they, too, have been found essential in the transaction of railroad business.

"Manufacturers of fireworks have a lively interest in the purchasing power of railroads, for a substantial part of their sales—$1,300,000, in fact—is made up of fusees and torpedoes which observant passengers may sometimes see flagmen place for the protection of trains. Textile manufacturers, too, are interested in the amount of table linen required for dining cars. Somthing like two million dollars of railroad earnings is required to pay for dining car linen annually and more than half as much goes for china. Then there is the linen for sleeping and parlor cars. Even the modest signal flags of red, blue, green or white bunting requires 2,400,000 yards of material costing $300,000 annually.

"Or take the familiar way-bill. The New York Central Lines last year purchased 7,000,000 way-bills at a cost of $260,000. Total expenditures for stationery and printing for the year were $1,900,000. A fair estimate of the portion of Class I Railroad earnings distributed annually among manufacturers of paper, pens, pencils, ink and other items which come under the head of stationery, and to printers, would be $19,000,000.

"The railroads are good customers for the farmer, too. In dining cars are served annually approximately 8,000,000 pounds of beef. It takes a herd of more than 30,000 cattle to supply this beef for only the choicest cuts are served in dining cars. Two million pounds of ham, 1,750,000 pounds of lamb chops, and 3,500,000 pounds of other meats, 3,250,000 pounds of butter, 6,000,000 quarts of milk, 27,000,000 eggs, 16,000,000 pounds of potatoes are among the items served annually in dining cars.

"Altogether, miscellaneous materials from fuel oil to dining car supplies to which I have referred, plus thousands of others that need not be named, call for nearly 19 cents of each dollar of railroad revenues, or approximately $1,950,000,000 a year.

"I have gone into these details to give point and driving force to the great fact that money paid for transportation does not come to rest in a railroad treasury, but continues uninterruptedly on its beneficent mission, carrying its blessing to every farm and factory, to every nook and corner of this broad land. Upon the diminishing remainder of the railroad's dollar the tax-gatherer has fixed his hungry eye. Today he demands about six cents of every dollar taken in, or a total of $350,000,000 for 1924. In eleven years railroad taxes have increased 160 per cent while dividends have decreasd 10 per cnt.

"We have now accounted for 85 cents of the railroad's dollar, leaving 15 cents which appears in statements as 'net railway operating income.' But do not make the mistake of thinking this represents the income of railroad owners. Since approximately 57 per cent of railway capital is borrowed there is a large sum to be paid in interest. This, with other charges, leaves to the railway owner an average of a little more than four and a half cents of each dollar. This is not sufficient to make railway stocks attractive to capital in competition with other forms of investment. What other industry can survive or has survived on such meagre return?

"To sum up, every one in all the land, is vitally interested in the railroads in two distinct ways:

"First, as the transportation agency which moves 96 per cent of all freight at rates so low that the farmer on the Pacific coast can afford to sell his produce to industrial workers on the Atlantic coast, while the latter can find a market for his wares in the most remote village of the Far West.

"Second, everybody is interested in the railroads as purchasers of whatever they have to sell. Railroad revenues cover a multitude of purchases. If the railroads are prosperous they are able to buy freely, quickening the pulse of commerce and industry everywhere; if they are not, they must cut their cloth accordingly, thus retarding trade."

Pennsylvania Railroad Section Motor Cars

Studies are being made by the Pennsylvania Railroad with a view to motorizing, so far as possible, all the forces engaged in the maintenance of tracks. According to data compiled in connection with this investigation the substitution of motor cars for hand cars for the purpose of transporting section gangs has proved so successful that about 1,000 motor cars are now in service and about 1,500 hand cars, formerly used, have been withdrawn.

One purpose of the study is to determine the most efficient and economical length of track which can, under varying conditions, be maintained by section gangs which vary from six to fifteen men in charge of a foreman. Among the factors to be considered are the number of main tracks, sidings, switches and the frequency of trains. On the four, six and eight track portions of the main line there are limitations to the use of motor cars on those sections which must necessarily be short in order that they may be maintained at a high standard.

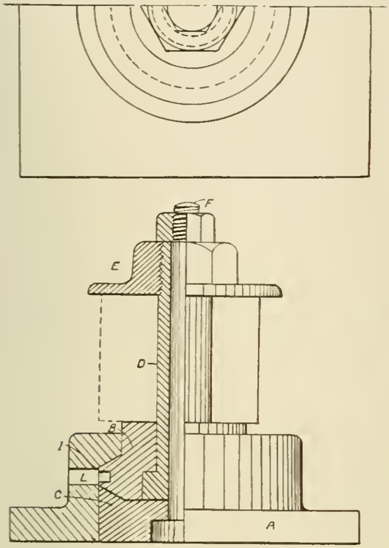
The use of motor cars on the Pennsylvania began several years ago but was only recently extended to cover the entire system. It has been found that, by employing larger gangs, the length of sections can be increased with no greater average loss of time, in moving between headquarters and the point where the work is to be done, than was the case with the smaller gangs and shorter sections when hand cars were used. It has also been found that a better class of men can be recruited for work on sections where motor cars are provided. Thus far a large reduction in the number of sections has been found possible.

Shop Kinks

Some Handy Attachments to Strop Tools in Use on the Erie Railroad

Chuck for Shaping Rod Brasses

This chuck is intended for the holding of rod brasses on a shaper. There is a base *A* which is bolted to the bed plate of the machine. This base is finished on the



Chuck for Shaping Rod Brasses

bottom and is bored out on the inside to the shape shown by the section at the left. Into this interior there are fitted the two collars *B* and *C*. The upper collar *B* fits into the upper portion of *A* and has two holes, one of which is shown at 1, drilled in its edge at right angles to each other. One hole, L, drilled in the base has a pin fitted in it, that has a teat to enter the hole 1. So that the collar *B* can be turned and fixed in either of two positions at right angles to each other. The collar *B* is bored to receive the hollow bolt *D* to the upper end of which the nut *E*, with the washer attached, is screwed. The brass to be finished is set upon the upper face of the collar *B* and is clamped to it by the washer nut, as indicated by the dotted lines.

This leaves the brass firmly clamped to the collar *B* and free to revolve in the base except for the pin in the holes 1 and *L*.

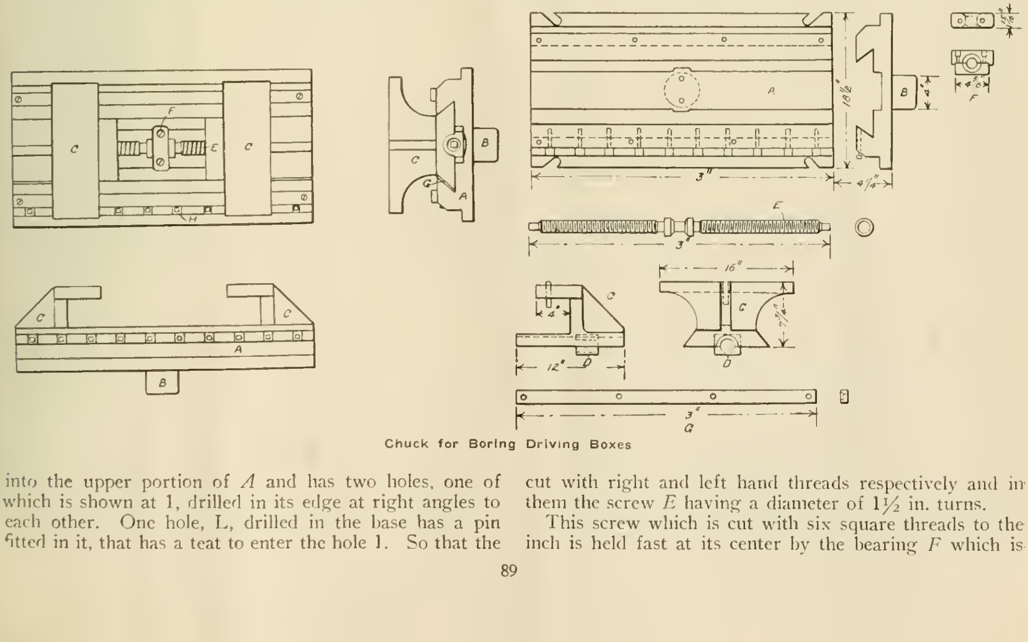
The collar *C* is screwed into the bottom of the base and fits up against the bottom of the collar *B*. It is counterbored on the underside for the bolt *F* which passes up through the hollow bolt *D*, and by means of the nut at the top serves to clamp the whole rigidly to the base. It will be seen that as the nut on the bolt *T* is tightened, the combination of the collar *B*, the hollow bolt *D*, the washer nut *E* and the brass will be clamped down against the collar *C*, which, being rigid with the base, holds the work firmly. When one side has been finished a slackening of the nut *F* loosens the work and makes it possible to turn it through 90 degrees and fasten it for shaping the sides of the brass that are at right angles to the first one.

Chuck for Boring Driving Boxes

There are a variety of methods of holding driving boxes on the boring machine while they are being bored. Frequently it is in the form of an angle to which they are bolted. Here is a regular chuck designed for the purpose.

There is a base *A* on the bottom of which there is a teat *B* turned to fit the hole in the center of the table so that no adjustment is required in the setting and centering of the chuck.

The top of the base is cut in the form of dovetail guides from end to end. In these guides the two jaws *C* are made to slide. They each carry a 2½ in. by 3 in. brass nut *D* that is let up into their under sides. These nuts are



Chuck for Boring Driving Boxes

cut with right and left hand threads respectively and in them the screw *E* having a diameter of 1½ in. turns.

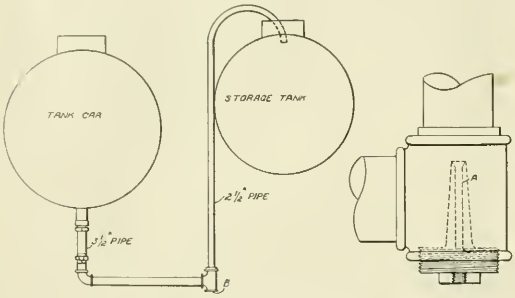
This screw which is cut with six square threads to the inch is held fast at its center by the bearing *F* which is made in two pieces and fastened to the center of the base by two ⅝ in. cap screws.

The operation is that of any universal chuck, where the two jaws are drawn together by a right and left hand screw. The base of the chuck has an overall length of 3 ft. and each jaw has a travel of 10 in. with a maximum opening between the two of 25 in., while the screw still retains a full thread in the nuts at each end.

Allowance for wear is made by the wearing strip which is held up against the faces of the jaws by a series of set screws as indicated at *H*.

Device for Unloading Fuel Oil

This is an arrangement of piping having an injector nozzle attachment for unloading fuel oil from tank cars when the storage tank is on a level with or above that of the car tank, so that a gravity flow cannot be used.



Device for Unloading Fuel Oil

A pipe is attached to the drain cock or pipe at the bottom of the car. This leads beneath the ground to a tee, *B*, from which a pipe leads up to a gooseneck that has a discharge opening at the top of the storage tank.

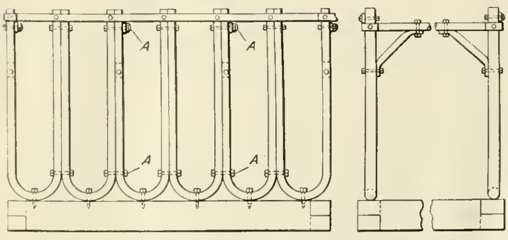
An air nozzle *A*, as shown in the detail engraving is screwed into the bottom of the tee *B* and to it a connection is made from a source of compressed air.

The oil flowing to the tee by gravity is caught by the escaping jet of compressed air and carried by it up through the pipe and discharged into the storage tank.

Tube Rack

In this case old tubes are made into a rack to hold others that are ready for use in the boiler.

The construction is exceedingly simple and substantial.



Tube Rack Made of Old Tubes

Old tubes of 2 in. diameter are bent into U shape and then set in the form of a rack, as shown and held together at the top and bottom by ½ in. bolts *A*.

The curved portion at the bottom is set upon and held to an old car sill by ⅝ in. by 6 in. lag screws. The tops are stayed across by a tube flattened at the ends and bolted to one leg of each *U* piece. This makes a rack 26 ft. across and consisting of six sections. Two such sections are used and these are set 15 ft. 10 in. apart from outside to outside. The cross piece at the bottom is an old car sill, as before, and the whole base measures 16 ft. across over all.

At the top, the frames are held by a length of tube flattened at the ends where it is bolted to the U tubes. This cross tie is stiffened by diagonal braces, also made of tubes with flattened feet for bolting, the bolts being set 30 in. from the junction of the cross tie and U tubes.

The rack is very commodious and stiff and costs little for labor, while the material of which it is made can be rated as so much scrap.

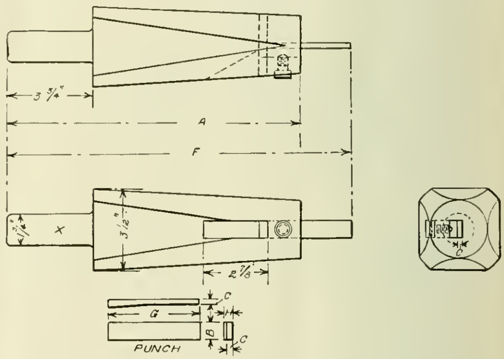
Tool for Punching Keyways in Bolts and Rods

This is a holder for a punch to be used in an Ajax bolt machine.

The dimensions vary with the size of the punch to be

All Dimensions in Inches

Size of Punch	A	B	C	D	E	F	G	H
5/16 x 1 5/16	16 1/2	1 5/16	5/16	3/8	1	13 1/4	6	9/16
1/8 x 1 1/8	15 3/4	1 1/8	1/4	3/8	1	11 1/8	4 1/16	3/8
3/16 x 3/4	14	3/4	3/16	3/8	3/4	12 3/4	4	5/16



Tools for Punching Keyways in Bolts and Rods

used. Provision is made for three sizes as noted in the table, which also gives the corresponding dimensions for other parts of the holder.

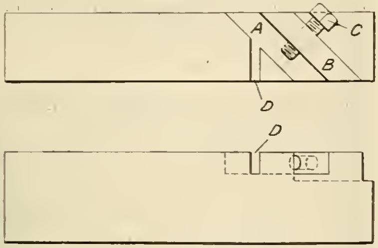
This holder has a stem *X*, 1¾ in. in diameter and 3¾ in. long, that fits the socket of the machine. It is turned on a taper from a diameter of 4 5/16 in. to 2½ in. and then flattened at the larger diameter to 3½ in. across the sides and fluted. In operation it acts as any other punch.

Jig for Cutting Packing Ring

This is a simple jig for holding a packing ring while it is being cut, and insuring that the cut is made at an angle of 45 degrees with the sides.

It consists of a 3 in. by 4 in. rectangular bar 16 in. long. Near one end a slot *A* 1/32 in. wide and ⅞ in. deep is cut and the end of the bar is also cut away to a depth of 1¼ in., leaving the upwardly projecting lug *B*, through which a hole is drilled and tapped for the ⅝ in. set screw *C*. Then a saw guide slot *D* ⅜ in. wide is cut with one edge on a line with the end of the slot *A*.

The ring to be cut is placed in the slot *A* and fastened by the set screw. The whole is clamped so that the saw



Jig for Cutting Packing Rings

or cutting tool passes through and in line with the slot *D*, and the cutting can be quickly and accurately done.

Snap Shots—By the Wanderer

The dining car offers such a fruitful source of interest for contemplation and comment that I cannot refrain from returning to it again, especially as there seems to be about as many angles from which it can be viewed as there are points in a circle. When I last commented upon it in the September, 1924, issue of Railway and Locomotive Engineering, I was moved thereto by the comparison of a dining car menu on which there were eighty odd items and where no one was really satisfied, with that of a hotel containing a few more than a dozen, where everyone was satisfied.

Since then I have had the pleasure of talking with some superintendents and stewards who have quite agreed with me as to the absurdity of what is being done, but who end with a shrug and the old, old appeal: "What can you do about it." And incidentally they have told of the commercial pressure that is brought to bear in the formation and modification of their menus.

For example, one superintendent told of a certain potato grown in a far western state that was famed for its deliciousness when baked. It was bought at a high price and listed by name on the bill of fare. But the road happened to run through the Evergreen region where potatoes are also grown but which incidentally are of little value for baking purposes. That little fact, however, was of no moment to the Evergreen potato growers. So they addressed an ultimatum or something that looked like it to the traffic manager of the A. B. C. whose dining car superintendent was rather proud than otherwise of the quality of his baked potatoes.

This may not be the exact form of the protest, but it contains the essentials.

Whereas the dining car menus of the A. B. C. Ry. contain the announcement of the serving of the Far West baked potatoes, and

Whereas the Far West district is not traversed by the A. B. C. Ry., and

Whereas the A. B. C. Ry. does traverse the Evergreen district, and

Whereas the farmers of the Evergreen district grow and have for sale potatoes that can be baked, Therefore be it

Resolved, that we the farmers of the Evergreen district will hereafter make all shipments of potatoes over the X. Y. Z. Ry. unless the words "Far West" before the words "baked potatoes" be stricken from the dining car menus of the A. B. C. Ry.

Well, business is business and difficult to get and to keep. So while Far West baked potatoes are no longer listed, they are still served, and the patrons get the best, though they are not told of it, while the feelings of the Evergreen growers are not hurt by having the Far West superiority flaunted before them, and all is once more quiet on the A. B. C.

The same thing occurred in the matter of ham and bacon, and probably ducks and geese and chickens would have come in for the same taboo had their names or sources of supply been mentioned. So this shows that there is nothing left for the dining car superintendent but to take his philosophy from Sairy Gamp and name no names.

I thought when I wrote of the eighty odd items on that dinner bill of fare that I had run across the high water mark, but, oh no, I have almost come to think that there is no high water mark, and that the tide is still rising and will continue to rise until as Noah's flood covered all the mountain tops so the dining car menus will continue to increase in comprehensiveness until every known edible is included.

Let me see, I recorded a list of eighty odd in September of last year, about a month ago in this year of grace I tried to pick out something palatable and at the same time digestible from a dining car menu containing one hundred and thirty-one items. It was a dinner. I had a choice of two soups, very modest, three sorts of freshly cooked fish and two of the canned variety, eleven varieties of hot meat and six of cold. And prices of the up upper class. Price about nine times that of the ordinary retail price of the article.

I stopped the steward as he passed, and asked him what he really thought, down in his heart of hearts, of that list. He smiled at first and was disinclined to talk, but a question of encouragement, if he didn't think it a piece of arrant nonsense, opened his mouth with the old query: "Well, what can we do about it? Here we carry five kinds of cheese and yet only this evening I had a complaint that we didn't have something more."

"Did that complaint come from a party who was probably in the habit of having a dozen varieties of cheese in its larder, or from one who bought a pound of cheese and ate of it regardless of its age, dryness and hardness until it was gone?"

"Well, it was of the pound of one kind at a time variety."

As I left the car he handed me his breakfast menu for the next morning. On it there were fifty-nine items.

My own home menu, with which I am quite content, usually contains about five. But, then, as the steward remarked, people have such a variety of tastes.

The trouble is that the dining car superintendents have cultivated such a variety of wants that none of us knew we possessed until they have become necessities, or at least we think they have, and "as a man thinketh so is he."

My personal interest in the matter is two-fold: I would like to be able to dine on wheels without paying ten times the retail value of what I eat and at the same time I would like to feel that for every mouthful that I take I am not an object of charity. In both of which desires I probably have the hearty concurrent sympathy of every dining car superintendent in the country.

But, in the language of the infamous Tweed and the despairing steward: "What are you going to do about it?"

As this is written it occurs to me that an easy if not workable solution is possible. Let us refer the matter to some autocrat of the smoking compartment. To one of those loud assertive individuals who hold forth in a loud, rasping monologue in the smoking room of the Pullman cars long after the common section has gone to bed and would have gone to sleep except for his penetrating voice which continues in unbroken verbosity despite the request for quiet that the porter has hung in front of him. Such a one can probably solve off-hand that vexatious problem of the railroad and the passenger. I wonder what it would be.

But after all the dissatisfaction on both sides, that of the passenger on the prices and the sometime quality of the cooking and that of the management at the failure to meet expenses, it is but fair to put the shot into the other end of the gun and fire it back with a word of commendation for what is accomplished. How many housewives would care to undertake to serve from two hundred and fifty to three hundred breakfasts or a hundred odd dinners from their home kitchen no matter how well it may be equipped? Yet that is not an unusual performance of a dining car steward from a mere alley of a kitchen. It also occurs to me that this same housewife, thrifty though she be, would think it something of a hardship if her husband should dictate what she should serve and the quantities, as well as what it should cost. But the steward has the menu and prices handed to him, the sizes of his portions specified, and told to feed a dozen hungry men for nothing and yet keep his food costs down to a little over forty per cent of his costs. This is making the Israelites provide their own straw for their brick making with a vengeance.

Then I wonder how the thrifty housewife would take to the idea of having her husband bring in a lot of Californians one day and ask her to cater to their tastes, and on the very next introduce a crowd from Louisiana who did not like anything that the Californians ate with so much gusto. Or how would she go about meeting the tastes of the patrons of grand opera tonight and the habitues of a burlesque show on two successive days? Which is a fair parallel of the meals ordered on a fast de luxe extra fare train and a slow local express. And all this at the dictates of a manager hundreds of miles away.

Sometimes a steward can draw up his own menu which has the advantage of enabling him to dispose of stock that is sometime unsalable if presented on a stock menu.

Then there is the high standard of cleanliness that is maintained. Fresh tablecloths at every meal whether they are used or not, for dust will come in and immaculate whiteness must be preserved. A whiteness that must raise envy in the breast of our housewives as she remembers the blue or saffron tints of her own linen. Then a slop from a coffee cup and off comes the otherwise spotless cloth to make way for fresh spotlessness for the next patron. The same for the jackets of the waiters. No care will warrant the use of one for a second meal, and often there is a change ordered between the start and finish of a serving.

The dishes are not costly nor are they cheap. A nick is as good as a break, and the cost of discards because of nicks and breaks on a high-class through line would make a nice living income for any family man.

When these accomplishments are considered, one is apt to forget the high prices and not always well-cooked food, until he meets with them again, and doff his hat in admiration of the men who can do such things with an alley for a kitchen and a ship's cubby for storage space.

Surely these people are conducting a charity institution where lack of appreciation is the outstanding characteristic of its beneficiaries. But, if report say true, that is the usual frame of mind of the inmates of all such places. Though in other places they are seldom, if ever, treated with the consideration that they are upon the American dining car. A consideration that some of us outside laymen think unnecessary, but which those in the game say must be given. But, of course, we outsiders, like the old maid who has never had any children, know exactly how they ought to be trained, though, if put to the test, might have some difficulty in giving specific directions as to just what should be done.

Unit Costs Are Further Reduced

How railroad managements are succeeding in reducing the costs of producing railroad transportation is seen in a report just issued by the Bureau of Statistics of the Interstate Commerce Commission. The figures are compiled from 161 reports from 176 steam railroads, and they deal with freight and passenger train service unit costs.

The costs per freight train-mile in November of 1924 as compared with November 1923 were as follows:

	1924	1923
Locomotive repairs	$ .403	$ .433
Train enginemen	.253	.253
Fuel for train locomotives	.430	.486
Enginehouse expenses	.086	.091
Trainmen	.295	.291
Other locomotive and train supplies	.104	.097
Total selected accounts	$1.571	$1.651

The costs per passenger train-mile in November of last year compared with November of 1923 were as follows:

	1924	1923
Locomotive repairs	$ .244	$ .269
Train enginemen	.131	.127
Fuel for train locomotives	.181	.209
Enginehouse expenses	.056	.061
Trainmen	.145	.139
Other locomotive and train supplies	.091	.095
Total selected accounts	$ .848	$ .900

New Line Opened in Florida

The Seaboard Air Line Railway has opened a new cross-state line through Florida, known as the Florida Western & Northern Railroad. This line connects the east and west coasts of the state and also provides connections of both coasts with points east and west. The first train, in four sections, carrying some 450 prominent guests from nearly every section of the country passed over the new road on January 25th.

The Florida Western & Northern is the only through line south of Richmond from eastern and western points to the east coast of Florida. The "Orange Blossom Special," is the premier train of the new road.

In his formal address at the ceremonies incident to the opening of the road, S. Davies Warfield, President of the Seaboard Air Line, said in part:

"Our country, second to no other in resources, has reached its present position in the financial and commercial world largely through developments by railroads. This was because those who were responsible for them were able to reach out into virgin unoccupied territory in the spirit of the pioneer. It was in this spirit that the undertaking in this State, now drawing to successful conclusion, was begun. It could not have been consummated unless there was sufficient latitude to give full play to initiative."

Fuel Consumption Shows Decreases

Compilations by the Bureau of Economics show that in the first eleven months of last year the pounds of coal consumed per passenger train car-mile were 16.9 pounds compared with 18.1 pounds in the same months of 1923.

The reduction of pounds of coal per passenger train-mile in the Eastern district was from 18.7 pounds in the first eleven months of 1923 to 17.5 pounds in the same period of 1924, a reduction of 1.2 pounds.

In the Southern district the reduction was from 19.3 pounds per passenger train-mile to 18.2 pounds, or a reduction of 1.1 pounds.

In the Western district the reduction was from 16.9 pounds to 15.6 pounds, a reduction of 1.3 pounds per passenger train-mile.

Railroads and Army Lay War Plans

The War Department and representatives of the railroads held a meeting on March 2nd in Washington at which plans for the operation of the railroads in the event of war were discussed.

The plans stressed that actual operation and control of individual railroads should be left in the hands of the executive staff and organization of each road, although the general direction of railroad transportation should be under an executive assistant to the Secretary of War.

"It should be the fixed policy of the Committee in carrying out this plan," the plan itself said, "to make the maximum use of individual companies as corporate organizations and not to interfere with any company in matters of management, operations or domestic arrangements, except when such interference may be absolutely necessary."

Major-General W. H. Hart, Quartermaster General of the Army, explained that the purposes of calling the conference were to arrive at plans which had been arranged prior to an emergency. He said:

"You known as well as I that it will not be possible for the railroads and the Army to co-operate effectively immediately upon the occurrence of an unfortunate emergency unless they spend some time together preparing and developing plans for such co-operation. That is why we have asked you to be here.

"We intend that in time of emergency, all requisitions on the railroads in the zone of the interior shall emanate from a single unit of our organization, namely, the Transportation Corps. The officials of that body will be vested with sole authority to call for equipment to meet the demands for the movement of men, animals and material. Competition among Army shippers will be eliminated."

Notes on Domestic Railroads

Locomotives

The Chicago, Burlington & Quincy Railroad is inquiring 13 Mountain type locomotives.

The Carnegie Steel Company is inquiring for 3 six-wheel switching locomotives.

The Southern Pacific Company has ordered one rotary snow plow from the American Locomotive Company.

The Midland Valley has ordered 5 Mikado type locomotives from the Baldwin Locomotive Works.

The Chicago, Rock Island & Pacific Railway has placed an order for 10 eight-wheel switching type locomotives with the American Locomotive Company.

The New York Central Railroad is reported to be inquiring for 75 Mikados and 25 switching type locomotives.

The Central of Georgia Railway is inquiring for 5 Mountain type locomotives.

The Kansas City, Mexico & Orient Railroad is inquiring for 4 Mikado type locomotives.

The Unity Railroad has ordered one Consolidation type locomotive from the Baldwin Locomotive Works.

The Chicago, Rock Island & Pacific Railway is inquiring for 10 Santa Fe type locomotives.

The Chicago Short Line Railroad has ordered one six-wheel switching locomotive from the Baldwin Locomotive Works.

The Denver & Rio Grande Western Railroad has placed an order for 20 narrow gauge Mountain type locomotives with the Baldwin Locomotive Works.

The San Diego Electric Railway has placed an order for one 60-ton electric locomotive with the Westinghouse Electric & Manufacturing Co.

The Temiskaming & Northern Ontario Railroad has placed an order for 3 locomotives with the Canadian Locomotive Company.

The Indiana Harbor Belt Railroad is inquiring for 5 eight-wheel switching type locomotives.

The St. Louis-San Francisco Railway is reported as inquiring for 20 locomotives.

The Tatum Lumber Company has ordered one Mikado type locomotive from the Baldwin Locomotive Works.

The Cornwall Railroad has ordered one Consolidation type locomotive from the Baldwin Locomotive Works.

The St. Louis-San Francisco Railway has ordered 15 Mikado type and 5 Mountain type locomotives from the Baldwin Locomotive Works.

The Sloss-Sheffield Steel & Iron Co., Birmingham, Ala., is inquiring for one locomotive for use on its new railway between Flat Top Mine and Banner, Ala.

Freight Cars

The Sloss Sheffield Iron & Steel Co., Birmingham, Ala., is inquiring for 75, 55-ton steel hopper cars and 25, 55-ton gondola cars.

The Southern Pacific Company has ordered 400 Hart selective ballast cars from the Rodger Ballast Car Company.

The Seaboard Air Line Railway has placed an order for 275 steel underframes with the American Car & Foundry Company.

The Chicago & Western Indiana Railway is inquiring for 280 underframes for ballast cars.

The Kansas City Mexico & Orient Railway is inquiring for 250 miscellaneous freight cars.

The Seaboard Air Line Railways has ordered 80 underframes for caboose cars which it will build in its own shops from the Richmond Car Works.

The Union Pacific Railroad has placed an order for 500 gondola cars with the Western Steel Car Company, also for 500 flat cars with the Standard Steel Car Company.

The Canadian Pacific Railway is inquiring for bids on the repair of 1,200 cars.

The Missouri Pacific Railroad is reported to have placed an order for 1,000 box cars with the American Car & Foundry Company.

The Craig Oil Company, Toledo, Ohio, has ordered 15 tank cars from the Standard Tank Car Company.

The American Rolling Mill Company has ordered 3 steel ore cars of 75 tons capacity from the American Car & Foundry Company.

The Minneapolis, St. Paul & Sault Ste. Marie Railway is inquiring for 10 milk cars.

The Quaker City Tank Line, Philadelphia, Pa., has ordered 200 tank cars of 10,000 gal. capacity from the American Car & Foundry Company.

The Waite Phillips Company, Okla., has ordered 50 tank cars from the Standard Tank Car Company.

The Piedmont & Northern Railway is inquiring for 150 automobile cars. These cars are to be standard 40 ft. 100,000 lb. capacity with steel frame and superstructure, roof and ends.

The Republic Iron & Steel Company is inquiring for 8 steel gondola car bodies, also 2 quenching cars.

The Chicago, Rock Island & Pacific Railway has ordered 1,200 box cars and 400 gondola cars from the American Car & Foundry Company.

The Pere Marquette Railway has ordered 11 steel underframes for caboose cars from the Pressed Steel Car Company.

The Carnegie Steel Company is inquiring for 50 gondola cars of 50 tons capacity.

The Empire Refineries, Inc., has placed orders for 200 class three tank cars of 8,000 gal. capacity, 30 class four tank cars of 8,000 gal. capacity and 2 two compartment tank cars of 6,000 gal. capacity with the Standard Tank Car Company.

The General Refractories Company has ordered 20 narrow gauge steel hopper cars from the American Car & Foundry Company.

The Chicago & Northwestern Railway is inquiring for 600 box cars.

The Swift & Company, Chicago, Ill., is inquiring for 300 refrigerator cars, also 300 underframes.

The Mexican Petroleum Company has placed an order for 500 tank cars with the American Car & Foundry Company.

The Boston & Maine Railroad is inquiring for material for 500 box cars which may be built in their own shops.

The McKean Country Refineries Company, Bradford, Pa., are inquiring for 50 tank cars.

The Andes Copper Mining Company is inquiring for 15 flat cars and 10 gondola cars.

The Minneapolis, St. Paul & Sault Ste Marie Railway has arranged for the purchase of 1,000 box cars, 500 gondola cars, 200 flat cars, 125 refrigerator cars, with the American Car & Foundry Company.

The Inland Steel Company has ordered 50 dump cars from the Western Wheeled Scraper Company.

Passenger Cars

The Delaware, Lackawanna & Western Railroad has ordered 40 milk cars from the Standard Steel Car Company.

The Erie Railroad is inquiring for 32 coach underframes.

The St. Louis-San Francisco Railway is inquiring for 10 baggage cars.

The Northern Pacific Railway is inquiring for 10 observation cars.

The Havana Central Railroad is inquiring for 8 interurban cars.

The Nashville, Chattanooga & St. Louis Railway is inquiring for 2 dining cars and 2 baggage cars.

The St. Louis Southwestern Railway is inquiring for 10 baggage cars.

The Northern Pacific Railway has ordered a gasoline-driven motor coach and trailer from the Oneida Manufacturing Company.

The Philadelphia & Reading Railroad has placed an order for one Brill-Westinghouse gas-electric car.

The Union Pacific Railroad has ordered 15 baggage cars from the American Car & Foundry Company and 15 coaches, 5 observation cars and 5 dining cars from the Pullman Car & Manufacturing Corporation.

The New York Central Lines is inquiring for about 70 cars for passenger service.

Building and Structures

The Delaware, Lackawanna & Western Railroad has awarded a contract covering the construction of a one-story shop at East Buffalo, New York, to cost approximately $150,000.

The Louisville & Nashville Railroad contemplates the construction of a large terminal at Leewood, near Memphis, Tenn.

The Texas & Pacific Railway will soon call for bids for the construction of a yard and engine terminal facilities at Alexandria, La., to be used jointly with the Missouri Pacific.

The Missouri Pacific Railroad plans the construction of a new freight house at Omaha, Nebr., to cost approximately $200,000.

The Texas & Pacific Railway is preparing plans for the rebuilding of its car shops at Marshall, Tex., which were destroyed by fire.

The Missouri, Kansas & Texas Railroad has awarded a contract to the Graver Corporation, East Chicago, Ind., for the erection of a water softener, with a capacity of 15,000 gal. per hour at Wichita Falls, Texas.

The Illinois Central Railroad has awarded a contract for the installation of its water supply facilities at Markham Yard, Chicago, Ill. The work will cost approximately $195,000.

The Colorado & Southern Railway has awarded a contract for the installation of an electric cinder handling plant at Trinidad, Colo.

The Chicago, Rock Island & Pacific Railway is calling for bids for the construction of a car repair shop at Hulbert, Ark.

The Texas & Pacific Railway plans for construction for the year including a new terminal freight yard at Dallas, Texas; a new terminal and enginehouse at Shreveport, La., and terminal improvements in New Orleans, La.

The Union Pacific Railroad will erect a 350-ton steel coaling station with sanding and water facilities at LaSalle, Colo., to cost approximately $65,000.

The Chicago, Great Western Railroad has awarded contract for the construction of 100-ton frame coaling station at Marshalltown, Iowa., to replace a coaling station which was destroyed by fire.

The Reading Company plans the construction of a new enginehouse, with repair facilities at Lebanon, Pa.

The Great Northern Railway has authorized the construction of water treating plants at Benson, Minn., a power plant at Minot, No. Dak.; an engine terminal at Troy, Mont., and gravel washing plants at Cinook, Mont.

The Long Island Railroad is about to commence construction of an addition to its Morris Park Shops, providing six overhauling tracks for electric equipment with overhead cranes and material handling facilities.

The Illinois Central Railroad plans the construction of a one-story passenger station at New Athens, Ill.

The Missouri Pacific Railroad plans extensive improvements to its rover terminal facilities at Natchez, Miss.

The Illinois Central Railroad has awarded a contract for the construction of foundations for the locomotive and car repair shops at Paducah, Ky. The buildings which are to be constructed include a locomotive erecting shop, locomotive repair shop, carpenter shop, foundry, boiler shop, blacksmith shop, power house, tank house and air brake shop. The cost will be approximately $6,000,000.

The Toledo & Ohio Central Railway is inquiring for bids covering the construction of a car dumper at Toledo, Ohio.

The Seaboard Air Line Railway is reported to be drawing plans covering the construction of an engine house and machine shop at Coleman, Fla., estimated to cost $70,000.

The Nashville, Chattanooga & St. Louis Railway has awarded a contract for the construction of reinforced concrete roundhouse at Hollow Rock Junction, Tenn., to cost approximately $70,000, to replace the one recently destroyed by fire.

The Pacific Fruit Express Co., San Francisco, Calif., has awarded a contract covering excavations for the new car shops at Nampa, Idaho.

The Bangor & Aroostook Railroad plans the construction of a reinforced concrete enginehouse with oil storage building at Millinocket, Maine, to cost approximately $70,000.

The Grand Trunk Railway plans the construction of a new enginehouse and repair shop at Muskegon, Mich., to cost approximately $100,000.

The Chesapeake & Ohio Railway plans the construction of shop extensions and improvements, new roundhouse and increased yard facilities at Russell, Ky., to cost approximately $2,000,000.

The Terre Haute, Indianapolis & Eastern Railway plans the reconstruction of its machine shop at Terre Haute, Ind., which was destroyed by fire.

The Pennsylvania Railroad plans installation of a steel escalator, 100 ft. long and 4 ft. wide at the Journal Square tube station in Jersey City, N. J.

The Southern Railway has placed a contract covering the construction of a reinforced concrete enginehouse and boilerhouse at Atlanta, Ga.

Items of Personal Interest

J. W. Brozo has been appointed division engineer of the Atchison, Topeka & Santa Fe Railway, with headquarters at San Marcial, New Mexico. He was formerly road master at Pueblo, Colo.

Thomas F. Lowry, superintendent of the St. Paul division of the Northern Pacific Railway, with headquarters at Minneapolis, Minn., was appointed acting general superintendent of the Central district of the Northern Pacific Railway, with headquarters at Livingston, Mont., to take effect March 1st, it is announced by **C. L. Nichols**, general manager.

Mr. Lowry takes the place of **T. H. Lantry**, granted leave of absence because of illness.

W. L. Huggins, Jr., has been appointed assistant to the vice-president of the St. Louis-San Francisco Railway, with headquarters at St. Louis, Mo., and will have charge of public relations, publicity and the St. Louis-San Francisco magazine.

O. F. Ohlson, assistant superintendent of the Montana division of the Northern Pacific Railway, with headquarters at Billings, Mont., was appointed acting superintendent of the St. Paul division with headquarters at Minneapolis, Minn., effective March 1st, taking the place of **Mr. Lowry**, according to the announcement of **W. H. Strachan**, general superintendent.

A. J. Dietrich has been made roundhouse foreman of the Santa Fe System, with headquarters at Bakersfield, Calif., vice **R. T. Gorman**, promoted, and **C. H. Wall** has been made division foreman, with headquarters at Richmond, Calif.

D. E. Nichols, trainmaster on the Pasco division of the Northern Pacific Railway, is appointed acting assistant to the general superintendent at Livingston, Mont., effective March 1st, taking the place of **R. T. Taylor**, assigned temporarily to other duties.

A. F. Blaess has been appointed chief engineer of the Illinois Central Railroad, with headquarters at Chicago, Ill., vice **F. L. Thompson**, promoted.

L. J. Gallagher has been made road foreman of engines on the Northern Pacific Railway, with headquarters at Missoula, Mont.

R. C. Williams has been appointed superitendent of the Memphis division of the Missouri Pacific Railroad, with headquarters at Wynne, Ark.

R. T. Gorman has been made division foreman on the Santa Fe System, with headquarters at Barstow, Calif., vice **C. H. Hall**, transferred, and **W. C. Sherman** has been made road foreman of engines with headquarters at Slaton, Texas.

George Willis has been made inspector of investigation on the Canadian National Railways, with headquarters at Edmonton, Alta., vice **D. McLeod.**

Woodward Hudson, vice-president and general counsel of the Boston & Maine Railroad, with headquarters at Boston, Mass., will retire, effective April 1st.

T. L. Simmons has been appointed chief engineer of the Board of Railway Commissioners of Canada, with headquarters at Ottawa, Ont., and **A. K. H. Drury** has been appointed assistant engineer succeeding Mr. Simmons.

A. A. Miller, superintendent of the Memphis division of the Missouri Pacific Railroad, with headquarters at Wynne, Ark., has been promoted to engineer maintenance of way and structures, with headquarters at St. Louis, Mo., succeeding **R. C. White**, promoted.

J. H. Tonge, superintendent of the Washington Terminal, with headquarters at Washington, D. C., has been appointed manager, and the position of superintendent has been abolished.

Andrew Halkett, superintendent of the Moose Jaw division of the Canadian Pacific Railways, with headquarters at Moose Jaw, Sask., has been promoted to acting general superintendent of the Alberta district, with headquarters at Edmonton, Alta., succeeding **J. C. Cameron.**

Edward H. Bannon has been appointed superintendent of the Chicago, Milwaukee & St. Paul Railway, with headquarters at Sioux City, Iowa.

C. McNay has been appointed assistant general manager of the Missouri Pacific Railroad, with headquarters at St. Louis, Mo. He was formerly office manager.

J. C. Whiteford has been appointed secretary & treasurer of the Louisiana & Southern Railway, with headquarters at New Orleans, La.

William Phillips has been appointed manager of the industrial department of the Canadian National Railways, with headquarters at Montreal, succeeding **W. P. Fitzsimmons.** Mr. Phillips was formerly European manager for the Canadian National Railways.

Carl H. Burgess has been appointed acting road master of the Northern Pacific Railway, with headquarters at Glendive, Mont.

Richard Brooks has been appointed division engineer of the Wheeling division of the Baltimore & Ohio Railroad, succeeding **A. M. Whoerner**, transferred. **J. L. Maher** has been appointed division engineer of the Charleston division, succeeding Mr. Brooks, and **G. B. Farlow** has been appointed assistant engineer of the Pittsburgh division succeeding Mr. Maher.

Fred H. Shaffer has been appointed assistant general manager of the St. Louis-San Francisco Railway, with headquarters at Springfield, Mo. Mr. Shaffer was formerly superintendent of the Eastern division in which capacity he was serving at the time of his recent promotion.

Supply Trade Notes

John R. Olsen, general sales manager of the **Central Electric Co.**, Chicago, Ill., has been promoted to vice-president and general sales manager; **Louis Siskind**, merchandise manager, has been promoted to vice-president, and **Jacob M. Lorenz**, manager of railroad sales, has been promoted to vice-president in charge of railroad sales.

The Moline Foundry Co., Moline, Ill., has changed its name to the **Moline Foundry & Machine Co.**

The Fairmont Railway Motor Co., Fairmont, Minn., plans the construction of warehouse.

The Crane Co., Chicago, Ill., has purchased the former station of the Atchison, Topeka & Santa Fe Railway at Phoenix, Ariz., and will erect a building costing $500,000.

The Union Tank Car Co., Cleveland, Ohio, is asking bids covering the construction of a car repair shop at Toledo, Ohio.

Oscar B. Cintas has been elected a vice-president and director of the **American Car & Foundry Co.**, succeeding **Charles S. Gawthrop**, deceased. Mr. Cintas has also succeeded Mr. Gawthrop as president of the **Railway Equipment Co. of Cuba**, which is a subsidiary of export company.

J. Lester Perry has been appointed assistant district manager of the **American Steel Wire Co.** at Worcester, Mass.

The American Steel Foundries, Chicago, Ill., has placed a contract covering the construction of a waste heat boiler room at East St. Louis, Ill., also contracts covering the construction of a pattern storage building at its Indiana Harbor plant at Indiana Harbor, Ind.

C. P. Whitcomb, formerly assistant sales agent of the **Griffin Wheel Co.**, Chicago, Ill., with headquarters at Boston, Mass., has been transferred to the Pacific Coast district and will have headquarters in San Francisco, Calif.

The Okonite Co. has opened an office at 310 South Michigan Ave., Chicago, Ill., to handle the sale of Okonite products in the Western territory. **Charles R. Brown** has been elected vice-president and will be in charge of the Chicago office.

J. C. Grimshaw has been elected treasurer of the **Chicago Pneumatic Tool Co.**, with headquarters at 6 East 44th St., New York, N. Y.

The American Car Wheel Co. has been merged with the **Southern Wheel Co.**, which is subsidiary of the **American Brake Shoe & Foundry Co.** The following officers will be in charge: **W. F. Cutler**, president; **F. C. Turner**, first vice-president; **C. C. Esdale**, vice-president in charge of operations; **C. E. Baurer**, vice-president, and **H. E. Lumpha**, vice-president.

The Pascal Rail Joint Co., 42 Broadway, New York, N. Y., has been organized to manufacture and sell a new type of rail joint.

The Ohio Locomotive Crane Co., Bucyrus, Ohio, will discontinue its offices at 30 Church St., New York City, and will be represented in New York by the **General Equipment Co.**, 342 Madison Avenue.

Lee C. Bullington has been appointed manager of the Cincinnati office of the **Westinghouse Electric & Mfg. Co.**, succeeding **Mr. James A. Brett**, deceased. Mr. Bullington was formerly assistant manager of the power department at Pittsburgh, Pa.

At a special meeting of the board of directors of the **American Car & Foundry Company**, **Herbert W. Wolff**, vice-president of the company, with headquarters at Chicago, Ill., has been made a member of the board of directors of that company. **G. R. Scanland**, formerly auditor, has been elected vice-president, in charge of financing and accounts, and has also been made a member of the board. **S. A. Mallepe** has been appointed assistant treasurer, succeeding **S. S. De Lano**, deceased. **E. S. Block** has been appointed assistant auditor and **Alma E. Jackson** has been appointed assistant treasurer.

E. A. Deeds has been elected a director of the **Pratt & Whitney Co.**, Hartford, Conn.

James F. Twohy has been appointed vice-president of the **Pacific Car & Foundry Co.**, Seattle, Wash. Mr. Twohy is also secretary of Twohy Bros., railway contractors of Seattle and Portland, Oregon.

E. J. Kulas has been elected president of the **Otis Steel Co.**, Cleveland, Ohio, succeeding **George Bartol**, resigned.

The sales department of the Baltimore office of the **Symington Company** has moved to New York and will continue under the jurisdiction of **R. H. Gwaltney**, vice-president, in charge of eastern and southern sales, with headquarters in the Woolworth Building, New York City.

Wright Sales, engineers, with office in the Maryland Trust Building, will continue to represent the **Symington Company** on the railroads having their principal offices in Baltimore.

E. I. Cornbrooks has been appointed sales manager of the **Newport News Shipbuilding & Dry Dock Company**, Newport News, Va., succeeding **Benjamin G. Fernald**, who has resigned.

W. R. Guinn, former manager of the fuel department of the **Combustion Engineering Corporation**, New York, has been appointed Pacific Coast agent, with headquarters at San Francisco, Calif.

The Chicago Metal Packing Company, Chicago, Ill., has changed its name to the **Chicago Rhopac Products Company.**

A. C. Cook, general sales manager of the **Warner & Swasey Company**, Cleveland, Ohio, has been promoted to vice-president and has been elected also a member of the board of directors.

Gardiner & Lewis, Inc., 30 Church St., New York, N. Y. At the annual meeting of the directors elected the following officers for the ensuing year: President, **Richard W. Lewis**; vice-president, **Russell B. Reid**; secretary and treasurer, **Jacob W. Winkler.**

Norman J. Keyser, formerly traffic manager of the **Buffalo Forge Company**, Buffalo, N. Y., has resigned to become head of the traffic division of the **Kardex Company**, at Tonawanda, N. Y.

The Premier Equipment Corporation, Houston, Texas, has been organized to take over the **Houston Railway Car Company** and will repair, buy and sell locomotives, cars and other railway equipment.

The Landis Machine Company of Waynesboro, Pennsylvania, manufacturers of thread cutting die heads and threading machinery, have opened an office in Detroit at 5928 Second Boulevard. **J. W. Frey** is in charge.

New Publications

Books, Bulletins, Catalogues, Etc.

A Study of the Locomotive Boiler. By Lawford H. Fry. Simmons-Boardman Publishing Company, New York. 157 pages, 6 in. by 9 in.

When a man undertakes a piece of work as a labor of love, it is usually well done. And this little book is not an exception to that statement. The author tells us that the book was written outside of the office and because of his interest in the subject.

Stated broadly, one of the prime objects of the book is to show that a very close approximation to the performance of a locomotive boiler can be obtained by calculation. He shows that the laws of heat production and heat transference are so well known that certain formulæ may be considered as established, and that the bases of their establishment are the long series of carefully conducted tests on the locomotive testing plants at Purdue, Altoona and Urbana.

In this study of the boiler the anatomy is discarded on the assumption that the reader is familiar with that and the sole attention is concentrated on the physiology. And this is handled thoroughly and concisely. The book, however, is not one to be read as a vacation's relaxation, but requires close attention on nearly every page. This demand for close attention does not mean that the book is not clearly written, for it is a model of concise and logical sequence of thought.

There are eight chapters that start out with a preliminary survey of the general features of boiler operation and then proceeds by progressive steps to the end.

Some of the work is more or less elementary, such as the description of the processes of combustion and the determination of the weight of the produced gases; but this is essential to the development of a logical sequence. And to those who are not familiar with these things, these pages can be recommended as models of clearness and conciseness.

It may almost be said that, with the opening of the third chapter on the "Method of Computing Heat Balances," the real treatise begins, that which has gone before being a mere preliminary canter, as it were.

In this the author states that an inborn liking for the conservation of personal energy has made simplicity attractive, and surely the methods of calculation that he has set forth show that he has achieved his object.

He takes the heat developed, and divides it into that utilized in evaporation and that lost by various means, and then goes on to show how each of these can be approximately calculated. Of course, Mr. Fry is not of a kind to claim absolute accuracy for these calculations but merely that they come so close to actual performances that the difference is negligible. And what is of more importance, though he does not make any such claim, the formulæ can be used to check the records of tests, and if the latter vary too much from calculated results, they may be looked upon with suspicion.

In short, the book is a critical analysis of a large number of tests, much of the data regarding which is given, and from them the fundamental principles are determined and reduced to simple formulæ. This includes a study of heat balances and boiler efficiencies, absorption by radiation in the firebox, heat absorption by the tubes and as affected by rate of operation and by boiler dimensions, the determination by calculation of smokebox temperatures, and, finally, an exposition of the method of plotting boiler efficiency.

A man would have to be exceedingly familiar with all of the phases of boiler performance who would not find something new in Mr. Fry's book, and he would have to be a designer of more than the usual excellence who could not find many valuable suggestions therein.

It is very much to be regretted, however, that it must be acknowledged that there is a fly in this valuable ointment. Scattered through the book are many typographical errors, mostly inconsequential, but a few serious. For example: the formula for heat radiation on page 65 does not check with the correct repetition of the same formula on page 68, and in one or two cases reference to the tables are in error. But with this exception, which is one of manufacture for which the author cannot be held responsible, there can be nothing but praise for this valuable little treatise.

Standards of the American Society for Testing Materials. Published by the society at 1315 Spruce street, Philadelphia, Pa. 1219 pages, 6 in. by 9 in.

This volume is issued triennially and contains all of the specifications that have been formulated and adopted by the society. The present volume contains its 220 standard specifications, methods of test, definitions of terms and recommended practices.

As already stated the volume is issued triennially and such standards as may be adopted by the society in the interim are published in a Book of Standards.

Before a standard receives the formal approval of the society, it is published for one or more years as a tentative standard.

There is an opening chapter on German Information regarding the object, status and activities of the society. Its growth, according to this chapter, has been very rapid, having risen from a membership of 70 in 1898 to 3,598 in 1924. One important committee of the society is the National Research Council, which was organized in 1916 to assist the government in the prosecution of the war. This has, since then, been permanently established in its useful work.

A glance through the contents of the book would seem to indicate that specifications have been adopted for almost every article of bulk manufacturing. Starting with ferrous metals, in the form of rails, forgings, finished products and castings, it proceeds through a wide range of non-ferrous metals, to cements, paints, lubricants, road materials, coal, coke, timber preservatives, insulations, rubber products and textiles.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

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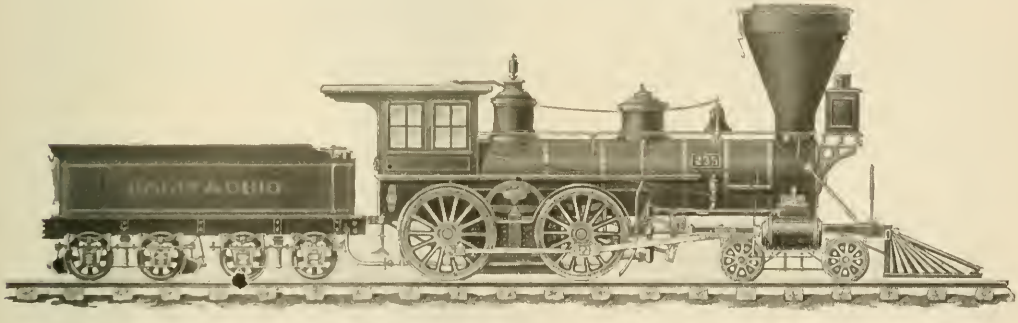
The Modernization of the Baltimore & Ohio Railroad Motive Power

By J. SNOWDEN BELL

The continuing progressive improvements that were made in the motive power of the Baltimore & Ohio Railroad, naturally reached the distinctly marked stage of what may properly be termed its *modernization*. The record clearly shows that this was commenced by Henry Tyson, who was appointed Master of Machinery in June, 1856, and occupied that position until the latter part of 1859. Mr. Tyson was one of the working organization, consisting of three departmental officers, by whom, under the executive head of the Baltimore & Ohio Railroad Co., its operations were conducted, viz: Wendell Bollman (designer of the Bollman truss bridge). Master of Road; Henry Tyson, Master of Machinery; and William S. Woodside, Master of Transportation. A short review of his work in regard to modification will indicate the extent to which his mechanical ability is entitled to fuller recognition than it has apparently received, and be of interest as an item of the history of locomotive engineering in the United States.

Henry Tyson, the accompanying portrait of whom will be recognized as an excellent likeness, by those who knew him, was born in Baltimore, Md., in 1820, and was first engaged in milling, on Commerce street, in that city, as a member of the firm of Tyson & Dungan. Succeeding his term of service on the Baltimore & Ohio Railroad, he was elected President of the Baltimore City Passenger Railway Co., and held that position for thirteen years, after which he was elected Fourth Vice-President of the New York & Erie Railroad, now the Erie Railroad, in charge of the Machinery Department. The difficulties with which this road was then contending were so great that Mr. Watson, the president, and Mr. Tyson, soon retired from office, the term of Mr. Tyson being only about twelve months.

In 1870, Mr. Tyson prepared a plan for the improvement of Jones' Falls, in Baltimore, for which he was awarded, by the Committee of Arbitration, the sum of $5,000, and in the Fall of 1875, Judge Bond, of the United States Court, appointed him receiver of the Chesapeake & Ohio Railroad. His services in this position were so effective and valuable that the Court awarded him the sum of $10,000, as his compensation for a comparatively brief term. He was shipping commissioner of Baltimore, at the time of his death, September 8th, 1877, at the early age of 57 years.



The Typical Mason Locomotive of 1857, Fig. 2

When Mr. Tyson entered upon the duties of Master of Machinery of the Baltimore & Ohio Railroad, in 1856, its motive power consisted of 208 locomotives, the latest of which was put in service in November, 1854. Some of these had been built as early as 1834, and about sixty were of dates earlier than 1849. The equipment was not, therefore, what could properly be termed a "modern" one. The valve gear of all the engines was of the "hook motion" type, and all the horizontal boilers (those of a few of the first built being vertical) had D section flat bottomed smoke boxes, with the then usual connections to the cylinders and frames, the weakness and lack of durability of which made these connections of a type which may not improperly be designated as "ramshackle."

Mr. Tyson's mechanical ability and broad and progressive habit of mind, readily recognized these, and other objections, and he at once began a course of modernization of the locomotive equipment, which was the foundation upon which present perfected types have been developed. William Mason, of Taunton, Mass., had just brought out a passenger locomotive design, which was beyond question, the most perfect of its date, and was immediately imitated by all the other locomotive builders of this country. Among the novel and valuable features of the Mason engine, was the bed plate or cylinder saddle, which was speedily recognized and applied by other builders, as being the strongest, simplest, and most durable means of connecting the locomotive boiler to the cylinders and frames that had ever been devised.

Henry Tyson

The Mason locomotive, in addition to simplification of structure and symmetrical design and proportions, presented the substantial advantages of the bed plate connection of the boiler to the cylinders and frames, and the operation of the valves by the Stephenson link motion. The value of these features did not fail to be appreciated by Mr. Tyson, who took the first step in modernization by ordering two passenger locomotives, Nos. 25 and 26, from Wm. Mason & Co., shown in Fig. 1, which were placed on the road in November, 1856. These engines differed from Mason's later practice, in having wagon top boilers, which were about 46 inches in diameter. Their cylinders were 15 x 22 inches, and driving wheels 60 inches diameter. One of them, No. 25, was included in the Company's exhibit at the Chicago and St. Louis Expositions, but was fitted with a stack and sand box of different patterns from those with which it was originally equipped.

While the writer remains of the opinion that the bed plate (subsequently modified, in many cases, by being made in two "half saddle" castings) originated in the practice of William Mason & Co., it is only fair to admit that an application of the general principle of the appliance, although structurally different, had probably been previously made by the Baldwin Works. In the first catalogue of the Baldwin Locomotive Works, published in 1871, it is stated that three engines were built in 1852, "with the cylinder flanges brought around under the smoke box until they nearly met, the space between them being filled with a spark box," and that subsequently, when the spark box was not used, they were cast so as to almost meet under the smoke box, and that *after the cylinders were adjusted in position,* wedges were fitted in the interstices, and they were bolted together. (Catalogue, page 40).

A locomotive of the 0-8-0 type, in which this construction was applied, is illustrated in Plates XLVIII and XLIX of Colburn's *Recent Practice in the Locomotive Engine,* 1860, by reference to which it will be seen that the cylinders were inclined, at an angle of about 15 degrees, on the sides of a round smoke box, and had inwardly projecting flanges, connected to the smoke box, and downwardly projecting flanges, connected to the frames. It is obvious that such a construction would be inapplicable in engines having cylinders set horizontally, or nearly so, and would involve radical redesigning to bring it to the form of a bed plate, properly so called, and operative as such.

Mr. Tyson's next step of advance was to order six first class passenger locomotives from William Mason & Co., Nos. 231, 232, 233, 234, 235 and 236, which were of the standard Mason type, and were placed on the road in August, 1857, following which a similar engine, No. 188, was built at the Company's Mount Clare Shops, and placed on the road in November, 1858.

The accompanying illustration, Fig. 2, correctly shows the typical Mason engine of 1857, the general design of which superseded all preceding ones, and was imitated by nearly all the locomotive builders of the country. The characteristic features of this design comprise the straight, or, properly speaking, telescope boiler, instead of the old hemispherical topped, or the wagon top pattern; horizontal cylinders, secured to the frame and to a round smoke box, through a cylinder saddle; wide spread truck; elimination of outside frame rails and other excrescences; ogee moulding dome and sand box tops;

Fig. 1—Baltimore & Ohio Railroad Locomotive, a Mason Engine of 1856

and a neater and more symmetrical arrangement of link motion and reverse gear.

No record of the total weight, or weight on driving wheels, of these engines, has been found in the records of the Mason Machine Co., or the Motive Power Department of the Baltimore & Ohio Railroad, but a substantially similar engine, built by William Mason & Co., in the same year, weighed 24 tons of 2240 pounds. The cylinders of these engines were 16 x 22 inches, and the driving wheels 60 inches in diameter. The boilers were of 5/16 iron, 46⅝ inches in diameter at the first ring, with a 24 inch dome over the firebox, which was stayed with crown bars. They had 106 tubes, 2¼ inches in diameter, and 11 feet 2½ inches long. Their firebox heating surface was 86.5 square feet, tube heating surface 694.5 square feet, total heating surface 781 square feet; grate area 15 square feet. They, at first, burned wood, but were designed to burn, and later successfully burned, bituminous coal, and for a time, were run with coke.

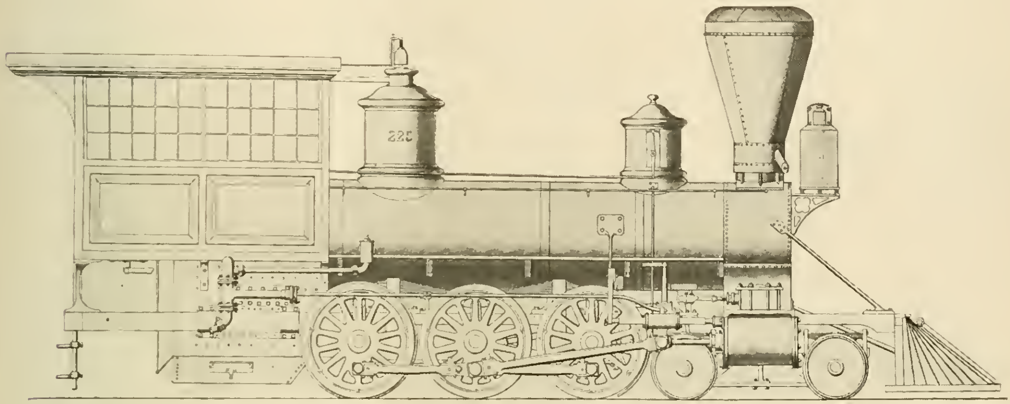


Fig. 3.—4-6-0 Type Freight Locomotive Designed by Henry Tyson in 1856

The Book of the Great Railways Celebrations of 1857, by Wm. Prescott Smith, 1858, quotes, on pages 47 and 48, Part II, a report on the performance of one of these engines, No. 232, the substance of which is as follows:

"It is well known that the most expensive item in the practical working of locomotives is fuel. The ordinary consumption of wood by first-class passenger engines in this hundred-mile run, between Martinsburg and Baltimore, is about four cords. This requires, as a rule, a special stoppage of the passenger train of four or five minutes above the Monocacy junction, in order to 'wood up.' Upon this engine, however, the run is made with the consumption of but two and a half cords of wood, which being less than the capacity of its tender, entirely dispenses with the stoppage for renewed supply. Although this reduced quantity of fuel is consumed, the engine has no lack of steam, but seems to equal to a more enlarged task even than hauling the heavy train which contains the great throng of Baltimore guests.

"Without enlarging too much upon these practical details, the subject is of such paramount importance in railway economy, that I have made a careful calculation, to show the actual advantages presented in this seemingly model locomotive. In the first place, the cost of wood used between Martinsburg and Baltimore is said to average $3.80 per cord, when prepared for the locomotive. The quantity consumed by the ordinary engines for the round trip of 200 miles is, say, eight cords, while, as I have stated, by the engine in question it is but five cords, being a saving of three cords, $11.40. The number of round trips made by the passenger engines during the year is about 150, by which it is evident that the total saving of wood reaches, in the course of a year, the large quantity of 450 cords, with the attendant reduction of $1,710. Assuming that there are twenty engines of this general character in use upon the Baltimore and Ohio Railroad, the saving to that Company would reach the enormous figure of $34,200 in this one particular of its working expenses. With regard to the consumption of oil, the same economy is effected in the use of this engine, there being but little more than half the usual quantity required for its supply. The saving of this item of running expenses is roundly estimated at the minimum of one gallon, costing $1.30, for the round trip of 200 miles, amounting to the sum of $195 for a year's operation for each engine. I learn that this estimate is fully verified by the Company's experience with the same make of engines on the Washington Branch."

At the time that Mr. Tyson assumed charge of the Machinery Department of the Baltimore & Ohio Railroad, most of its freight locomotives were of the 0-8-0 "Camel" type, built by Ross Winans, of Baltimore, there being 109 of these in service. There were also 17 engines known as the "Hayes ten wheelers," which were operated on both passenger and fast freight trains, and a few 0-8-0 locomotives, called "Company 8 wheel engines." The Camel engines embodied many novel and valuable features, and, up to this time, it is entirely probable that no other freight locomotive had been built that developed as great power and gave as good results in service. It was, however, observed by Mr. Tyson, the correctness of whose judgment is undeniable, that they were objectionable in certain errors of design, the chief of which was the absence of a leading truck, as well as in structural weaknesses of serious character. The Hayes ten wheelers were not, in most particulars, subject to these objections, but many of their features, especially their valve motion, and cylinder connections, were clearly in need of modification.

To the end of effecting such improvement in the freight locomotive equipment as the conditions above noted indicated to be necessary and desirable, Mr. Tyson, in 1856, designed a locomotive of the 4-6-0 type, a side view of which, reproduced from Plate 5 of the *Supplement to the Report on the Railways of the United States,* by Captain Douglas Galton, R. E., London, 1858, is shown in Fig. 3. Most of the drawings for these engines, copies of a number of which appear in Capt. Galton's report, were made by the late M. N. Forney, who was then chief draughtsman at Mount Clare Shops, after the close of his apprenticeship in the shops of Ross Winans, and were of the same grade of excellence as uniformly characterized Mr. Forney's work. The only record of these drawings now in existence, is that made in the report referred to, and it is much to be regretted that the originals, together with many other interesting ones of locomotives of other types, were destroyed, by the order of a subsequent Superintendent of Motive Power.

Upon the completion of this design, Mr. Tyson sent to Ross Winans, on September 13, 1856, a request to be informed whether he desired to make a bid for the construction of five of them, according to specifications to be sent to him. Mr. Winans declined to do so, but offered to build the engines, if allowed to deviate from the specifications, by making the diameter of the wheels, and the valve gear and frame, similar to the Camels. This offer was at once rejected by Mr. Tyson, who contracted with A. & W. Denmead & Sons, of Baltimore, for seven locomotives, in accordance with his specifications, Nos. 222, 223, 224, 225, 226, 227 and 228, which were placed on the road at different dates, between April and December, 1857. Two more were built at Mount Clare Shops, Nos. 229 and 230, in September, 1857.

This correspondence was the beginning of a lengthy personal controversy, carried on in pamphlets and newspaper articles, between Mr. Tyson and Mr. Winans, as to the relative merits of the ten wheel and Camel engines, the result of which was that no more of the latter were built for the road, the company having apparently accepted, as final, the position taken by the heads of its operating departments, as to the undesirability of further application of that type of engine.

The Tyson ten wheel engines weighed 61,830 pounds, of which 48,200 pounds was on the driving wheels. The cylinders were 18 x 24 inches; driving wheels, 50 inches, with chilled cast iron tires, and boilers of telescopic form, 46 inches diameter of first ring, with crown sheet radially stayed by 7/8 inch stay bolts. The inside firebox was of copper, except the crown sheet, and was 66 x 41 inches inside dimensions, giving a grate area of 18.5 square feet. A variable exhaust, of the Winans "plug" type, was applied.

These engines were the first on the Baltimore & Ohio Railroad that were equipped with the Gooch, or so-called "stationary" link motion, which is shown in Fig. 4, reproduced from Plate 10 of Capt. Galton's report before referred to. The Gooch link motion was also applied by Thatcher Perkins, who succeeded Mr. Tyson as Master of Machinery, in the many successful ten wheeled and eight coupled locomotives designed by him, and built at Mount Clare Shops, and by other locomotive shops, for the road. In the Perkins engines, this valve operating mechanism was modified by connecting the front end of the die rod to an arm on a shaft journalled on the frames, immediately behind the smoke box, and extending a rod backwardly from another arm on this shaft to the lower valve rocker arm. By this means, a materially increased radius of the link was made available, this radius being, in the Perkins engine, 55 inches. It is probable that the Gooch link motion was approved, and adopted by Mr. Tyson and Mr. Perkins, for the reason that it did not involve variation of lead at different points of cut off.

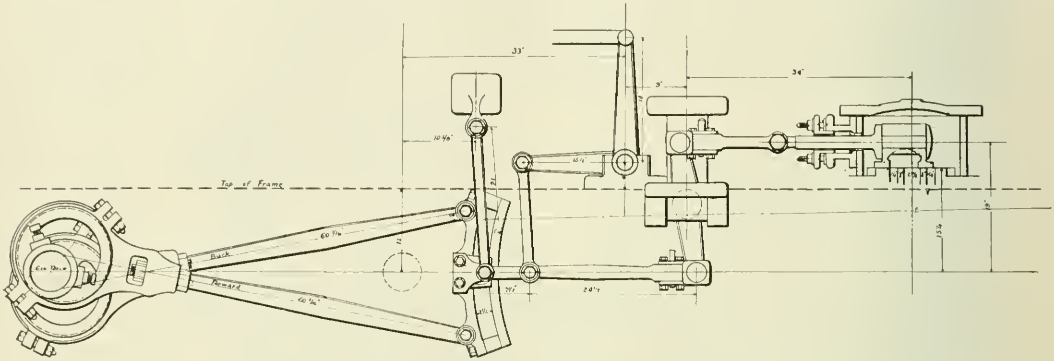


Fig. 4—The Gooch Link Motion as Used on the 4-6-0 Type Locomotives of the Baltimore & Ohio Railway in 1856

The fact that only nine Tyson ten wheel engines were built, and that, subsequently, a considerably greater number of Hayes ten wheelers, *modified* by the application of cylinder saddles, link motion valve gear, and wide spread trucks, were built at the company's Mount Clare shops and put in service on the road, and also that objection was made to the Tyson ten wheelers on the ground that they did not have sufficient weight on their trucks, and were consequently liable to derailment, may be held to indicate that Mr. Tyson's last step of modernization was not an entirely successful one. But, even if this view be a correct one, the fact remains that he is entitled to the substantial credit of having actually modernized the existing ten wheel engine of the road, and brought about the introduction of the leading truck, in its freight equipment.

If the controversy betwen himself and Ross Winans could, as was most to be desired, have been amicably adjusted, the skill and ingenuity of the latter would have doubtless led to the development, by him, of the 2-8-0 type, as a compromise between the Camel and the ten wheel engines, and the progress of locomotive improvement would, by the co-operation of two designers of unquestioned ability, have been correspondingly advanced towards the culmination reached in the perfected types now in general service, which are fully represented in the the present equipment of the Baltimore & Ohio Railroad.

A further substantially valuable result of co-operation by Mr. Tyson and Mr. Winans, would have been that of maintaining in operation Mr. Winans' locomotive works in Baltimore, which, prior to the Company's adverse decision as to his engines, had been doing a large and profitable business, and contributing materially to the prosperity of that city, but were, soon thereafter, closed by reason of the injurious effect of the disapproval of the Camel engines. If these works had continued to be operated, it is not unreasonable to believe that Baltimore would, today, have the credit and advantage of being the location of a large and successful locomotive building establishment.

Causes of Pitting in Locomotive Boilers and Means of Prevention

By C. H. Koyl, Engineer Water Service, Chicago, Milwaukee & St. Paul Railway

For many years the study of the cause of boiler pitting was handicapped by a confusion of terms between chemists and boilermen, the word "cause" meaning one thing to the chemist and quite another to the boilerman.

Chemists were seeking for the cause of corrosion of iron, meaning by the term corrosion not only pitting and grooving in boilers but rusting of iron in general; and they sought not so much the physical causes which lead up to this as the chemical conditions under which it takes place. They had in succession the "oxide" theory, the "acid" theory, the "electrolytic" theory, the "biological" theory, and others; but in 1922, by a continuous series of eliminations, they were finally able to agree that corrosion takes place only under water, or at least in the presence of moisture, and that its cause, or the chemical condition under which it takes place, is the presence of "hydrogen ions" in the water.

On the other hand, the boilerman, who knows little about "hydrogen ions" wants to know whether pitting is due to something in the water in the boiler, and if so what; or to the kind of metal of which the boiler is made; or to the temperature of the boiler, or its shape, or to the number and location of its injectors, or what not, always meaning by the word "cause" something under the control of the man who made the boiler, or of the man who runs it.

Accepting the statement on which all leading chemists have agreed that pitting can take place only in the presence of "hydrogen ions" in the water, there yet are two distinct methods by which water becomes charged with hydrogen ions—first, by adding acid, second, by electrification. And this tallies exactly with our statement of last year, founded on observation, that there are two kinds of pitting in locomotive boilers, one due to acid, and the other due to electric action. But, for the boilerman, there are seven or eight conditions of water or metal to be guarded against under these two general headings.

Pitting by sulphuric acid, which in this country can best be observed in the vicinity of the eastern coal mines, is very characteristic in locomotive boilers. It always commences about the firebox, where both iron and water are hottest; shows its first effect where the skin of the metal has been weakened by bending or punching or havy hammering; and gradually works forward, so that in the course of time it may reach the front of the boiler. Therefore, from our point of view water contaminated by the eastern coal mines is to be avoided as one cause of pitting.

Water from swamps and stagnant ponds, and decomposing sewage none of which are acid in the cold, will yet pit boilers because they are converted into acids by the heat of the boiler. Therefore, to the boilerman, water from swamps and stagnant ponds, and streams containing sewage are to be avoided as a second cause of pitting.

When the acid in the water is very weak, it has been noticed that the only parts of the boiler affected are those where the smooth skin of the metal has been broken or weakened by rough handling. It may be by scratching a flue as it is being worked through the flue sheet; it may be by excessive rolling near the flue end; it may even be by rusting in the open air; but whatever the cause of breaking the hard smooth finish on the steel, it is to be avoided as a third cause of pitting.

It is quite generally known that the chemical action of acid can be prevented by neutralizing the acid by lime and soda-ash before the water goes to the boiler.

On the line with which I am connected there is some pitting due to the above causes, but not much. Most of our pitting is of the electric order.

This electric pitting in locomotive boilers is also very distinctive in character. It commences at the front end of the boiler where the water comes in, and follows the course of the water toward the firebox though the pitting seldom reaches more than half way back. In its early stages it is found only on the three outer rows of flues, on the front belly plate, and on the front ends of the flues near the flue sheet, but it gradually works toward the firebox.

Also, this kind of pitting is found only in boilers fed with water rich in sodium sulphate or sodium chloride, say 20 grains per gallon as the water goes to the boiler. These alkali salts are chemically neutral to iron at boiler temperatures, but are good electrolytes, that is, they make easy the passage of electric current through the water; and these circumstances are the starting point for the belief that in this case the "hydrogen ions" necessary for pitting are the result of electric action.

Furthermore, it has been apparent of late years that electric pitting is of very small amount unless there is oxygen in the water; this because, in electric pitting, the atoms of metallic iron must be dissolved in the water, and since water can hold in solution only an infinitesimal quantity of iron the water would soon become saturated and the pitting cease unless something in the water continuously combined with the iron to take it out of the water and leave room for more iron. This something is oxygen.

Therefore, for electric pitting there must exist simultaneously three causes or conditions—electric potential from the iron in the water, alkali electrolyte in the water, and oxygen in the water. If we can eliminate any one of these three conditions, we can prevent electric pitting.

For practical purposes we may at once give up hope of getting rid of alkali water, because on the Great Plains between us and the Rocky Mountains there are many thousands of square miles with no other kind of water. It is true that I can show you in print, and signed by a noted engineer the proposal to evaporate all this water, and then condense it for locomotive use; and it is true that the chemist of a leading railroad proposed about the same time to freeze all this water and store the ice for locomotive use; but while each method would give us nearly pure water, yet either would cost too much. Therefore our efforts for preventation of electric pitting must be limited to the elimination of either electric potential or oxygen.

You know that between any two pieces of metal under water there is a tendency to generate an electric current if they differ in chemical constitution or in physical condition even the smallest amount. Steel is composed of iron and several other things, and under high-speed manufacture cannot possibly be absolutely uniform in texture and in hardness over the surface of even one flue. There are bound to be spots from which small electric curents tend to flow to other nearby spots, and if they do flow they take atoms of iron with them, and the result is holes in the steel, or pits. This kind of action is known as electrolysis and its cause is inherent in the steel.

Other metals, such as wrought iron and copper are more uniform in texture than steel, and both have been tested in boilers and found to pit less. But, in addition to the greater cost, there are other reasons why neither of these metals has come into general use for boiler sheets or flues.

Also, it has been found that if an electric battery is carried on the engine, with its positive pole connected to the water and its negative pole connected to the boiler shell, the water can be kept at a higher electric potential than the metal, and that thus electrolytic currents are prevented and pitting is stopped.

But all these more or less expensive or cumbersome remedies have been held in abeyance because it became evident a few years ago that we had not learned all that was to be known about electrolytic pitting. As noted above, this kind of pitting shows principally on the front half of the boiler. But presumably the steel is of the same kind from one end of the boiler to the other, and, if electrolytic pitting were controlled entirely by the quality of the steel, pitting should be uniform from end to end of the boiler. Also the flues at the hot end of the boiler are held in the flue sheet by copper shims, and if pitting were due entirely to difference of metal, then steel flues should pit most rapidly in contact with copper; but they do not.

Evidently the presence of alkali water and of the electrolytic difference of potential between hard spots and soft spots on steel, and between steel flues and copper shims, are not enough to produce pitting; and just as evidently the third and necessary factor is in the water when it comes through the boiler check valve, and is used up when the water is half way back to the firebox; and just as evidently, the discovery and proof of this third factor is the key to the prevention of electrolytic pitting.

At first I thought that a difference of electric potential between the boiler metal and the water existed when the water entered the boiler, and might be sufficient to last until the water was half way back and thus explain pitting on the front half of the flues and none on the back half. This electric charge, positive on the metal, negative in the water, does exist when the water has passed the boiler check valve; it is always present while the injector is in operation, but I have never found it of sufficient force or quantity to account for the pitting in the front half of the boiler. The phenomenon will require further study because it certainly has some effect on the pitting, but I am convinced that it is not the controlling factor.

The one remaining active content of the water as it enters the boiler is oxygen, and we have enough proof now to enable us to say that this small amount of oxygen, one part per hundred of the water by volume and only twelve parts per million by weight, is the factor which insures pitting in the front half of the boiler; and that there is seldom electric pitting in the back half of the boiler, because there is not enough oxygen to last.

We have been a long time making this discovery because we all thought that electrolytic potential in the presence of alkali sulphate was enough, and it was only when we separated acid pitting from alkali pitting and found that alkali pitting is confined to the front of the boiler that we were led to study the influence of oxygen in this kind of pitting.

The proof is complete when we find that the presence of a feedwater heater, which nearly eliminates oxygen, is sufficient to practically stop pitting in stationary boilers. Feedwater heaters for locomotives are new in the United States but they are in successful use and some of them are of a type that the oxygen can escape while the water is being heated. On one of them attached to a locomotive we have conducted a series of daily tests for two months, and find that on the average 80 per cent of the oxygen is eliminated.

A locomotive feedwater heater saves 10 per cent of the fuel and water, and pays for itself in a year or so; and it will not be any added expense to get rid of oxygen and thus prevent nearly all electric pitting. Therefore, I say with confidence that the days of electric pitting in the northwest are numbered.

Rail Employment Steadier Last Year

Variations in the number of employes on the railroads during 1924 were considerably less than in 1923 in spite of the fact that traffic fluctuations in 1924 were much larger than in 1923.

The number of men employed in every month in 1924 was less than in 1923, the average number of 1,770,391 for the year being 102,379 less than the average number employed in 1923.

The number employed in 1923 varied from 1,779,516 in January to 1,973,505 in August, a difference of 193,989.

In 1924 it increased from 1,749,927 in January to 1,822,616 in October, and then declined to 1,736,699, the maximum fluctuation being 85,917. This decline from October to December was less than in the corresponding period of 1923 when the reduction in the number of employes was 142,715.

To what extent changes in conditions and changes in policy caused the fluctuations in employment to be so much less last year than the year before it is not yet possible to say, but the facts show that efforts made by the managements to bring about greater stability are meeting with success.

Last autumn a committee was appointed by the Association of Railway Executives to study and report, in co-operation with the Interstate Commerce Commission, ways and means of stabilizing employment on the railroads.

Designating Freight Trains by Name

Fast through freight trains on the Pennsylvania are to be designated by names instead of the usual numbers or symbols in future. The new names that have been chosen are intended to appeal to the imagination. They typify speed and certainty; in some cases they have historic significance, and in others are related to the character of the service which the train performs. For example, the old designation "Star Union Line" has been revived for the fast freight to Chicago from the Atlantic Seaboard. This will perpetuate the name of the first through fast freight line operated between the East and West. Another name of interest is "The Gas Wagon," selected for the eastbound train from Detroit to seaboard, which largely carries automobile freight.

It is expected that the names of the fast freights will become as well known as are the names of such passenger trains as "The Broadway Limited," "The Congressional Limited," "The Southwest Limited," "The St. Louisian," etc.

The Engineer as an Executive

By JULIUS KRUTTSCHNITT, Chairman, Executive Committee, Southern Pacific Company

Before a joint meeting of the Metropolitan Sections of the American Society of Mechanical Engineers, American Society of Civil Engineers, American Institute of Electrical Engineers, American Institute of Mining Engineers, and the New York Electrical Society, held in New York on March 18th, Julius Kruttschnitt, chairman, Executive Committee, Southern Pacific Company, delivered an address: "The Engineer as an Executive." In this address Mr. Kruttschnitt, in an able manner and on a subject on which he is so thoroughly qualified to speak, reviewed the duties and responsibilities of the chief executive officer of a railroad, the difficulties which he must encounter, and the problems that have been solved. Brefly, he referred to nearly every phase of railroad operation including a review of those problems which remain unsolved. Mr. Kruttschnitt spoke as follows:

To correctly judge the qualifications of "The Engineer as a Railroad Executive," a comprehensive survey of the duties devolving on the chief executive officer of a railroad under present day conditions and of the difficulties which he has to overcome. Not only must we consider the problems that require solution but we must take into account the limitations imposed by law on the revenues of railroads and the extent of control of their expenses that the executive is permitted to exercise. It seems appropriate, therefore, to introduce a quite full outline of the problems that confront the responsible managing officer, the extent to which so far he has solved them, and to what extent they remain unsolved, after which we shall endeavor to show how the engineer has risen to new responsibilities, and what recognition stockholders and directors of railroads have accorded to his fitness to administer their properties.

Fundamentally, a railroad is a huge manufacturing plant designed to convert the energy locked up in fuel into work for transporting persons and property on specially designed roadways. The energy conversion is by means of individually operated locomotive units, and the success of the entire plant, measured by the spread between production costs of output, measured in passenger-miles and ton-miles, and selling prices depends on the efficient working of each individual unit.

To attain the maximum or even moderate success in creating a margin between the cost and sales prices of output, the necessary executive and administrative work can best be done by men specially trained in those branches of knowledge that contribute most to the efficient operation of railroads, on the degree of which depends success or failure; and the most important duty of the Chief Executive is to so select his official staff as to attain the best results. To pass intelligently on the qualifications of his staff and their recommendations that may reach him,—in other words, to avoid being a mere rubber stamp to approve whatever is laid before him,—requires a fair knowledge of the functions of each department head by the Chief Executive.

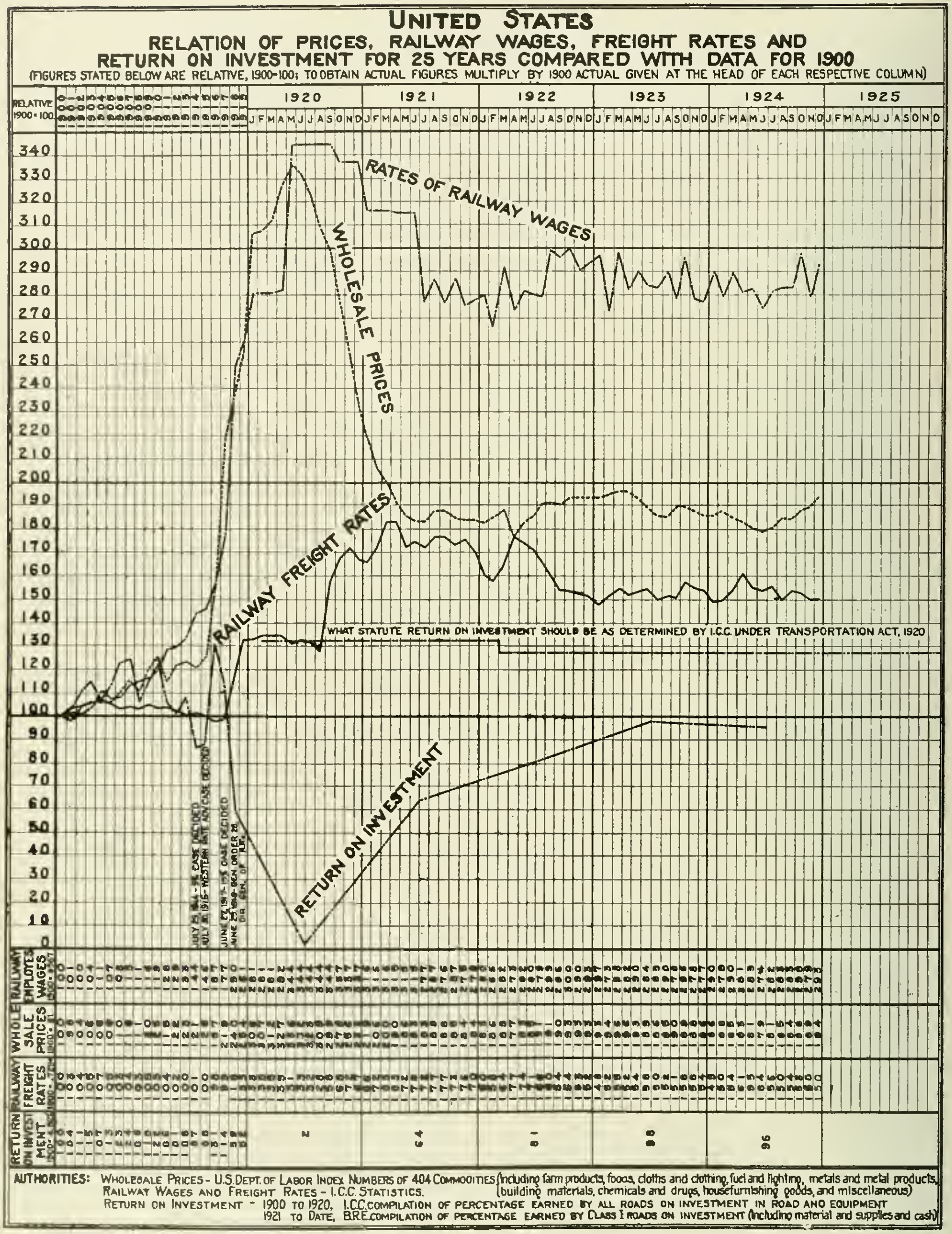
At the outset, let us explain the causes that have brought about the epochal changes in the conditions of the railroads in the first quarter of the twentieth century, conditions that have obstructed successful operation to an extent never theretofore encountered, and then show how American talent has adapted the railroads to these new conditions and so far has averted bankruptcy and ruin.

From the attached graph it will be observed that the rise of prices of oil commodities throughout our country, that was started by the outbreak of the World War in the summer of 1914, culminated in the United States in May, 1920, when the index number of wholesale prices showed an increase of 236 per cent above the corresponding number in 1900. Starting from the base index number—taken as 100 in 1900—there was a slight fall in 1901, but in 1902 prices were 4 per cent above 1900 and, with some reversals, the rise was continuous to the outbreak of the World War, when they were 20 per cent higher than in 1900. At the date of our entry into the war, the index number of wholesale prices was 120 per cent above 1900. The fall from the peak of 236 per cent over 1900 in 1920 was rapid to 83 per cent above 1900 in the middle of 1921, since when there have been fluctuations leading to the figure of 94 per cent above 1900 in December, 1924.

During the 17 years from 1900 to 1917, the average railway freight rate in the United States remained nearly stationary. True, there were fluctuations that affected the average but never sufficiently to raise it over 5 per cent to 7 per cent above 1900, so that when the United States entered the World War the average freight rate was almost exactly the same as it was 17 years theretofore, but in 17 years average prices had risen 120 per cent and wages of railway employees had risen 77 per cent. At the beginning of the century, 25 years ago, the average operating ratio for all the roads of the United States was 65 per cent. Under Government operation it rose in 1920 to 94.3 per cent and for the twelve months of 1924, after four years of private operation, it fell to 76.14 per cent. These data are quoted to show how the spread between revenues and expenses has shrunk, and how narrow a margin exists at the present time out of which to pay interest on obligations and dividends on stocks.

It will be observed that the percentage return on investment that was 4.52 in 1900 substantially vanished in 1920 on the return of the railroads to their owners by the Government, and never since that time has equalled the 1900 return. For 1924 it was only 96 per cent thereof, or 4.35 per cent, and it has fallen still farther below the statutory return for two years of 6 per cent, prescribed by Congress as reasonable and allowable, from March, 1920, to March, 1922, and 5¾ per cent from March, 1922, to date.

The figures we have quoted show the wide difference in the kind of managing talent required on railroads now and 25 years ago. At the end of the nineteenth century, 35 cents net out of every dollar could be turned into the treasury; while at the present time only 24 cents, or 32 per cent less, can be turned in, it requires the closest kind of management and the services of very much more highly trained executives to meet all money requirements other than mere operating expenses out of 24 cents out of every dollar. To get the most out of fuel, the largest material item of operating expenses, stresses the efforts of substantially every department on a railroad, and to obtain the best results requires the highest talent in a great many different branches of engineering. The course of civil engineering in our leading universities embraces courses in the allied sciences of mechanical and electrical engineering, and the important principles of physics, chemistry, geology and economics, so that the executive who has enjoyed the training afforded in a civil engineering course is peculiarly well fitted for co-ordinating and guiding the


UNITED STATES
RELATION OF PRICES, RAILWAY WAGES, FREIGHT RATES AND RETURN ON INVESTMENT FOR 25 YEARS COMPARED WITH DATA FOR 1900
(FIGURES STATED BELOW ARE RELATIVE, 1900=100; TO OBTAIN ACTUAL FIGURES MULTIPLY BY 1900 ACTUAL GIVEN AT THE HEAD OF EACH RESPECTIVE COLUMN)
RELATIVE 1900=100
1920
1921
1922
1923
1924
1925
RATES OF RAILWAY WAGES
WHOLESALE PRICES
RAILWAY FREIGHT RATES
WHAT STATUTE RETURN ON INVESTMENT SHOULD BE AS DETERMINED BY I.C.C. UNDER TRANSPORTATION ACT, 1920
RETURN ON INVESTMENT
RAILWAY EMPLOYES WAGES
WHOLESALE PRICES
RAILWAY FREIGHT RATES
RETURN ON INVESTMENT
AUTHORITIES: WHOLESALE PRICES - U.S. DEPT. OF LABOR INDEX NUMBERS OF 404 COMMODITIES (including farm products, foods, cloths and clothing, fuel and lighting, metals and metal products, building materials, chemicals and drugs, housefurnishing goods, and miscellaneous)
RAILWAY WAGES AND FREIGHT RATES - I.C.C. STATISTICS.
RETURN ON INVESTMENT - 1900 TO 1920, I.C.C. COMPILATION OF PERCENTAGE EARNED BY ALL ROADS ON INVESTMENT IN ROAD AND EQUIPMENT
1921 TO DATE, B.R.E. COMPILATION OF PERCENTAGE EARNED BY CLASS I ROADS ON INVESTMENT (including material and supplies and cash)

numerous operating activities on railroads and for securing the maximum output of salable products at minimum costs. An analysis of operations that produce transportation units will show that the engineer who has been trained to secure desired ends in the most practical, efficient and least expensive way can best contribute to the success of a railroad enterprise, and will indicate the directions in which he should prepare himself in college for executive duties, and will correspondingly indicate to the owners of railroads, other things being equal, the qualifications to seek in managers.

We repeat that viewing the railroad as a manufacturing plant designed for the sole purpose of creating the maximum of transportation units out of the minimum of fuel units the greatest efficiency will be attained by that railroad whose executives co-ordinate best all departments and concentrate their activities on increasing output, from the sale of which the railroad must secure its revenues.

Enumerating some of the activities of a railroad will show how numerous are the demands made on a Chief Executive, and at the same time will show to a certain extent how the problems that confront him have been partially solved or are still demanding study for their solution.

Executive Department

The wise executive will spare no expense in establishing an Accounting Department to keep track of earnings and expenses, to record the history of operations, to act as general inspectors, to expose poor results as prerequisites to their correction; to work up promptly cost data of every important item of operating expense and as promptly to put them in the hands of all concerned. While the experience of the men who make the decisions will usually keep them from going far wrong, yet in matters involving millions in both capital and operating expenses, a railroad officer should not be satisfied unless he has definite figures on which to base decisions. The record traffic handled with record efficiency in 1917 was the response of the railroads to the monthly data sheets first issued by the Railroads' War Board; these are now issued in even more detail by the Interstate Commerce Commission and the Bureau of Railway Economics. Fuel accounts kept with individual engineers and firemen and locomotives furnish railroads with data from which to decide definitely what type of locomotive is the most economical for their use, and whether the expense of applying and maintaining some of the many fuel-saving devices is warranted.

"The location of a railroad is given in its constitution. It may be sick almost unto death with accidents of construction and management, but with a good constitution it will ultimately recover." The Board of Directors, advised by the Chief Executive, must pronounce on the location of the railroad between its termini; it allots the amount of money to be spent on construction; fixes the grade and curve systems, because the ideally perfect railroad, between given points, should be absolutely straight and of uniform grade, that is, devoid of undulations in alignment or profile. The expense of operation will increase in proportion to the grade and curve resistance involved in departures from the ideal line, and the extent of departure must be authorized by the Board, on which devolves the duty of providing the money for construction. Whenever a ton weight is lifted one foot, an amount of work equivalent to moving it 333 feet over a straight, level track is spent; and every time a ton weight of train is forced through 100 feet of one degree curve, the work done in deflecting it from a straight to a curved path is equivalent to moving the same ton over 16 2/3 feet of straight, level track. The equated length of the old line of the Central Pacific between Ogden and Lucin, Utah, compared with the new Lucin Cut-Off line is as 280 to 129 miles, one pound of fuel on the new line moves as much tonnage as 2.2 lbs. on the old.

The Executive Department must determine the justifiable outlay to reduce grades and curvature on existing lines, as obviously the expenditure necessary to obtain a straight line between two points without any undulations in grade might be commercially prohibitive. It is therefore of the greatest importance for the commercial success of a railroad to balance the money cost of approaching as nearly as possible ideal conditions with the expected benefits.

Motive power can often be economized by expensive physical improvements, such as installing automatic block signals, redesign of terminals, modernizing roundhouses so as to utilize the residual heat from incoming locomotives to raise steam on outgoing ones, and by increasing the number and lengths of sidings to save on the line. On the executive rests the responsibility of balancing the interest, maintenance and depreciation costs on large capital expenditures against possible savings, and of providing the necessary capital if the investment is justified.

Traffic Department

The Traffic Department is the sales department of the railroad, and its contract specifications as to loads in cars and character of service exert a profound influence on net earnings. It requires 41 per cent less power to haul 50 tons of lading in one car than in two of the same class and weight, and 53 per cent more power to haul a given load at 40 than at 20 miles per hour.

Maintenance of Way Department

The resistance to traction of locomotives and cars varies between wide limits with the condition of the track. The train resistance figure commonly used of six pounds per ton of 2,000 pounds at low speed assumes track in good condition. It may very easily be two or three times that amount on track laid with light rail, poorly maintained, in bad surface and with low joints, etc. The heavier the rail and the better the ballast, the easier it is to maintain good alignment and surface, the less will be deflection under loads, and the less will be the work required to force the wheels out of the depression caused by weak and yielding joints.

Maintenanee of Equipment Department

About one-fifth of all locomotive coal, or 25,000,000 tons, in 1921 was consumed when the locomotive was not doing useful work: in firing up, in waiting for trains, in standing on sidings and passing tracks, in delays at terminals, drawing fire and waiting at ashpits. This consumption is not productive nor is it all waste. By redesigning terminals and increasing lengths and numbers of sidings the waste can be minimized. Ingenious graphs on which obstructions to traffic are likened to obstructions to flow of water in incrusted pipes have proven of great assistance to indicate how to increase capacity of line and defer double tracking.

In designing locomotives, the features exercising the greatest influence on fuel efficiency are:

Careful and expert proportioning of engines, boilers, fireboxes, grates, flues, draft appliances, so as to produce by their combination the most perfect device to extract their full heat contents from fuels. But little over 8 per cent of the energy in fuels is now extracted and converted into work.

While it is customary to speak of the waste of fuel in the average locomotive, we must not forget the extremely unfavorable conditions under which it is required to work. Space limitations have thus far prevented the successful use of condensing engines, and thus it has been deprived of the advantage of 12 to 13 pounds additional effective cylinder pressure. It is driven through all kinds of weather at high speed, so that radiation losses are excessive. To meet the demands made on its boiler for steam, explosive draft must be used, which expels much unburned fuel from the firebox; the resultant effect of all of which is evidenced in low thermal efficiency.

With the increase in the power of locomotives and the use of higher steam pressures, mathematical talent to replace rule of thumb has been called on to compute stresses and to proportion parts. Questions as to adoption of alleged improvements are difficult to decide, as they involve first cost, interest, maintenance and depreciation, their possible effect on engine failures and the idle time of locomotives while undergoing repairs. Sometimes economy of operation is sacrificed to facilitate adjustment and repairs, as when outside valve gears replaced the original Stephenson link motion.

The practice of buying locomotives regardless of their adaptability to special service, as was done during Federal control, simply because they could be built in quantity at some reduction in cost, is recognized by competent judges as the poorest kind of economy.

The Brake thermal efficiency—or percentage of energy in fuel transformed into work—of reciprocating, condensing, stationary steam engines is (boilers included) 19.0%

Of steam turbines 19.2%

Average of eight large power-plants (boilers included) 13.3%

While the thermal efficiency of non-condensing steam locomotives at maximum capacity, equipped with proven fuel-economizing devices, is from .... 7.3% to 8.1%

Some of the problems that have been closely studied and have been solved to a greater or less extent are:

Brick Arches

Brick arches built into the firebox mix the entering air thoroughly with the combustible gases rising from the fire and save on some types of locomotives about 12 per cent.

Superheating

The advantages resulting from the use of superheated steam are due mainly to two properties:

(a) Prevention of cylinder condensation
(b) Larger volume of steam per pound

Since the cylinder takes the same volume per stroke for the same cut-off, it is obvious that substantially less pounds of steam will be used for the same work done.

Superheating may save 20 per cent of fuel.

Feed Water Heaters

Feed water heaters utilize waste heat to raise the temperature of the feed water, thereby relieving the fuel in the firebox from heating the cold feed water from an average of 60° Fahr. up to 220° Fahr. and saving about 10 to 14 per cent of fuel.

The combined average effect of these devices in saving fuel on passenger and freight locomotives of various types at various speeds in actual service is given below, but we must not forget that these figures vary widely for different locomotives, speeds and classes of service, thus:

	Average, various types and speeds
Arch	9%
Superheater	20%
Feed water heater	10%
Combined	34.5%

The savings claimed for the various fuel-saving devices are gross figures. The cost of applying them is quite large, and in some cases not justified by the age or obsolescence of the locomotive; in others, is beyond the financial ability of railroads to apply them; hence we must be careful to balance cost of interest, maintenance and depreciation against the value of the fuel saved. The net saving so determined—not the gross—will show whether the money to provide the appliances can be providently expended or not. Experience shows that thus tested the gross saving of superheaters is reduced from 20 per cent to about 17.4 per cent; of feed water heaters from 10 per cent to about 6 per cent.

Boosters

Under normal conditions a locomotive can haul as much, or even more, load than it can start. The booster consists of a pair of independent engines coupled to the trailer wheels of locomotives, thus utilizing weight not otherwise used for traction, in starting and quickly accelerating trains and in reducing violent shocks in starting, which are so hard on draft gear and the temper of passengers. As it cuts out automatically at a speed of 10 miles per hour, it uses steam at low speeds when the boiler can over-supply the main cylinders. It is, therefore, an indirect but valuable fuel saver through increased locomotive capacity. The booster can add about 10 per cent to the starting drawbar pull of heavy freight and as much as 25 to 35 per cent to the starting drawbar pull of lighter passenger locomotives.

Feed Water Purifiers

1. After selecting the softest natural feed waters, such others as we may have to use should be chemically treated to reduce objectionable impurities to a minimum. A conservative estimate of the effect of scale one-sixteenth inch thick on flues is to increase fuel consumption 10 per cent. The Hungarian State Railroads on 3,000 locomotives use a mechanical feed-water purifier mounted on top of the boiler. The water on entering the purifier is subjected to full boiler pressure and temperature, and deposits its scale in and on this adjunct to the boiler instead of in the boiler and on the flues. With reduction of scale there is a direct saving in fuel consumption, while a reduction in frequency of boiler washings saves considerable time and fuel. Without the purifier, locomotives washed on an average of every five days require washing, with the purifier, every 54 days.

Lubrication

2. All journal bearings must be carefully lubricated to reduce friction; so must the center and side-bearings of cars, the friction of which prevents the adjustment of trucks on entering and leaving curves, and thereby in the aggregate causes a heavy increase of the resistance to traction that the locomotive must overcome.

3. Wear on all wheels of locomotives, tenders and cars must be watched. If the threads are worn hollow or flanges worn vertical, the areas in contact with the rails when cars are oscillating or rounding curves will be increased and friction correspondingly increased. A heavy freight locomotive, tender, caboose and 60 freight cars are carried on over 500 wheels; a slight increase in the friction on a few of them only would, in the aggregate, create a heavy drag on the locomotive.

Flange Lubrication

4. Flange lubrication reduces friction between rail and flanges, and therefore has a substantial effect in

reducing fuel consumption. On two roads where flange lubrication was used, locomotive tires showed average miles between turnings of 33,000 and 44,000 miles, respectively, compared with 16,000 and 23,000 without. Wear on rails in curves shows a reduction of as high as 87 per cent. On one road of excessive curvature and grade the life of locomotive tires was increased 375 per cent with flange lubrication.

Fuel Specifications

5. To insure full heat value the specifications for fuels purchased should cover their value in B.t.u's.

Maximum Loads in Vehicles

6. Freight cars should be fully loaded as far as may be. The resistance of a train of empty freight cars may run up to eight pounds per ton; that of cars with average loads to six pounds per ton, while that of heavily loaded cars, of total weight, 60 to 70 tons, may be as low as four pounds per ton. The load, in other words, should be carried in as few cars as possible.

Reduction of Dead Weight

As the expenditure of fuel in hauling a ton is the same whether or not it is paying freight, it is evident that the smaller the percentage of nonpaying or dead weight to total weight moved, the smaller will be the cost of hauling the paying freight.

The United States Railroad Administration 50-ton, single-sheathed box car weighs 47,200 pounds.

American Railway Association 50-ton box car design, 42,400 pounds.

Excess weight of U. S. R. A. car—4,800 pounds, or 11.3 per cent.

Based on 1923 data, the saving in fuel by eliminating this excess weight, is $9.77 per car per year, or $4.10 per ton, which, capitalized at 5 per cent, shows that an initial expense of $82 in building a car is justified to reduce its weight one ton.

As far as practicable all weight in a locomotive above what is needed for adhesion to develop traction should be eliminated.

Boiler design to suit class of service, and character of fuel, requires considerable flexibility in this principle.

Stimulation of Interest and Co-Operation in Saving Fuel

Assuming that locomotives are properly maintained, in order to obtain the best results from burning fuel we must inspire the interest and secure the co-operation of the men on the footboards of 65,000 traveling power-plants. How these are attained will appear from a brief of the practice on a large system covering many states and operated under the most varied topographical and climatic conditions.

1. In addition to inspection at each terminal of engines on arrival and again before departure to insure correction of all defects before the engine begins its trip, very thorough monthly inspections are made of all parts of the engines, boiler and appliances, draft arrangements, etc

2. Classified statistics supply a complete history of operation. To be of most use they are issued immediately after the occurrences they record.

(a) A fuel bureau receives report of train and locomotive movements within two days after movement. Ton-miles, fuel consumed per 1,000 ton-miles, tons per train for each individual locomotive and each individual engineer and fireman are then computed, and the results put into superintendent's hands three to six days after movement, so shortcomings can be detected and quickly corrected.

(b) Monthly statements of individual performance of engineers, firemen, and locomotives are displayed on bulletin boards.

(c) A sheet recapitulating results by divisions is issued monthly.

3. On each division a fuel committee composed of 4 engineers, 4 firemen, 1 conductor and 1 brakeman, serves for six months and holds meetings bi-monthly, the superintendent acting as chairman. The meetings are well advertised and are attended by the superintendent's staff and employees from all related departments, who offer suggestions freely. Experts on operating methods and appliances deliver addresses. Motion pictures illustrating actual road conditions are exhibited. Minutes of meetings are widely distributed and published in employees' magazines.

4. To create emulation between divisions, a red silk banner is awarded quarterly to divisions showing greatest improvement in the previous year.

5. Gold-plated cap badges are awarded quarterly on each division to the engineer and fireman showing best fuel record in through and local freight and passenger service.

6. Each superintendent publishes the names of five engineers and five firemen having the best fuel records for the month in through and local freight, passenger and yard service on a roll of honor, which is posted in roundhouses and printed in employees' magazines. A letter of commendation is sent to each man whose name appears on the roll.

7. The company sends yearly, at its expense, 38 men consisting of an engineer and a fireman from each division with the best fuel records, as its representatives to the annual convention of the International Railway Fuel Association.

As a result of the policy described and of many fuel-saving devices, the company referred to moved 50 per cent more gross ton-miles per pound of fuel in 1924 than in 1913.

Transportation Department

About 20 per cent of all locomotive fuel is consumed when the locomotive is not doing useful work.

(a) Avoidable losses of fuel used in firing up; losses from unconsumed fuel drawn from fireboxes, from blowing off and cooling down at end of runs; losses incurred while waiting for water, sand and other supplies on roundhouse tracks can be very greatly lessened by reducing the frequency of these occasions by lengthening locomotive runs. It is not uncommon now to run freight locomotives over two or three freight divisions, and passenger locomotives over four before cooling them. The following are some examples of modern practice:

PASSENGER

Road	Runs 575 miles and over	Mileage
Southern Pacific	Los Angeles, Calif., to El Paso, Texas	815
M. K. T.	Parsons, Kan., to San Antonio, Texas	678
Union Pacific	Kansas City, Kan., to Denver, Colo	640
Southern Pacific	San Antonio, Texas, to El Paso, Texas	620
A. T. & S. F.	Winslow, Ariz., to Los Angeles, Calif	602
Union Pacific	Denver, Colo., to Ogden, Utah	577
Southern Pacific	New Orleans, La., to San Antonio, Taxes	575

Four locomotives only are used on the Southern Pacific to haul passenger trains from New Orleans to San Francisco, 2,490 miles.

FREIGHT

Road	Runs 575 miles and over	Mileage
Southern Pacific	El Paso, Texas, to Del Rio, Texas	453
Southern Pacific	Sparks, Nev., to Carlin, Nev	387
Southern Pacific	Houston, Texas, to Algiers, La	362
Southern Pacific	San Antonio, Texas, to Fort Worth, Texas	352

(b) Good dispatching will reduce the number of needless stops, and careful planning will avoid fuel waste from locomotives standing in sidings because of poor meeting points, and from idle time at terminals waiting for trains.

To stop a freight train of 66 cars weighing with locomotive and tender 6,204,000 lbs., moving at a speed of 40 miles per hour, and to restore that speed requires a consumption of 380 lbs of coal.

(c) The economy of moving tonnage in as few cars and trains as possible and reduction of empty mileage is obvious.

[On account of limited space available, it is necessary that we publish Mr. Kruttschnitt's paper in two sections. The second installment will appear in our issue for May and will deal with the trend of current and future economic development.—Eds.]

Pyle-National Turbo-Generator for Train Lighting

A Simple and Efficient Device for Continuous Train Lighting

It is now something more than twenty-five years ago that the Pyle company exhibited an electric head light at a Saratoga convention of the Master Mechanics' Association. The outstanding feature of the exhibition was its application to a locomotive and the distance (nearly a mile) at which a road crossing could be seen. The device consisted of a small turbine, direct connected to a small generator supplying current to an arc lamp.

Since that time there has been a constant application of research and experimental work, until a few years ago the company developed a complete, self-contained turbo-generator set adapted for train lighting. This has been improved upon in detail from time to time until, in its latest development, it has taken the form shown in the accompanying engravings.

The turbine, and armature are mounted upon the same shaft, which is driven at a normal speed of 3,600 revolutions per minute, and generates a current of 32 or 64 volts, according to its type. The speed is under automatic control and the voltage line is practically straight or flat throughout the whole range of the demands that may be made upon the device.

Taking up the construction of the machine in detail and starting at what is the right hand end of the engraving, where the turbine is located we turn, first, to the turbine itself.

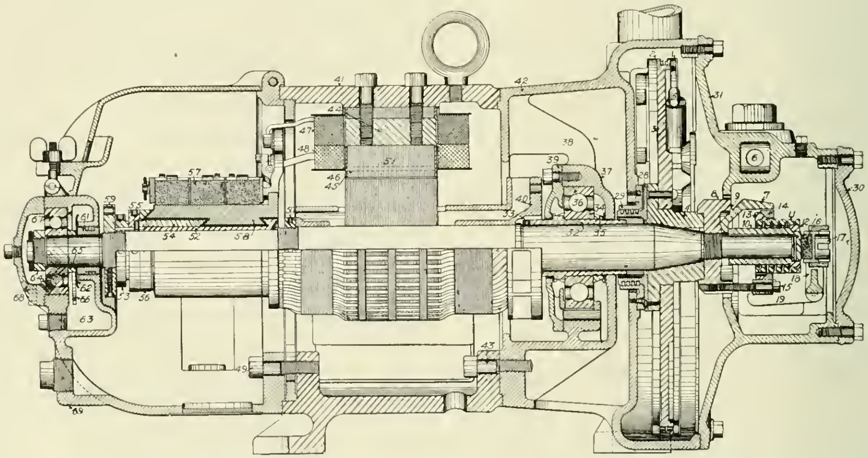
It is built up of two set of blades, 1 and 2, which are attached to the central web 3. This, in turn, is riveted to the flanged hub 4, which is attached to the shaft. Steam is delivered to the blades or buckets 1 on or against their inner periphery by the nozzle 5.

The steam passes outwardly through these buckets into a passover passage, not shown in the engraving, which is in the outer casing. This passover leads the steam from the outside face of the buckets 1 and discharges it from a nozzle against the lips of the outer periphery of the buckets 2. With an outside diameter of 17 in. and a rotative speed of 3,600 revolutions per minute, the peripherical speed of the turbine is about 16,000 ft. per minute. At the same time the total steam consumption is low.

The speed of the turbine is controlled by a throttling governor, the valve of which is placed in the opening 6, and is made the subject of a special engraving, which should be considered in connection with the main illustration.

Taking up the governor it is of the rotating ball or weight type whose weights are formed by the approximately horizontal arm 7 of a bellcrank lever that is pivoted against the rotating unit and collar 8 on the knife edge 9.

As the arm 7 moves outwardly under the influence of the centrifugal forces the radial arm presses against the



Pyle-National Turbo-Generator for Train and Locomotive Lights sleeve 10 and tends to move it to the right. This movement is resisted by the helical spring 11 which works under tension. It is held at the outer end by the collar 12 and at the other by the collar 13. The collar 12 has a beveled bearing surface where it is in contact with the end of the sleeve 10, and the collar 13 has a similar bearing against the larger holding collar 14. These beveled surfaces leave the spring perfectly free to rotate under the torsion stress to which it is subjected as it is stretched or compressed. Meanwhile, the collar 14 is held to, and made to turn with, the unit 8, by a series of tap bolts 15, having a long thread. By means of these bolts the collar 13 may be drawn in towards the nut 8, and thereby a greater tension be given to the spring which is held at the outer end by the collar abutting against the sleeve 10.

This embraces all of the rotating parts of the governor. The first moving part in direct contact with the rotating parts is a carbon plug 16, which is set in a recessed turretted plug 17. This, in turn, is screwed into the hollow end of the vertical arm 18 of a bell-crank lever by which the horizontal motion of the rotating parts of the governor are transferred to the stem of the throttling valve. The horizontal arm 19 of the bellcrank bears at its end against the lower end of the valve stem 20.

This valve stem is a plain straight stem with a circumferential groove cut in it at 21. A collar is slipped over it at this point and its metal spun or pressed into the groove so as to hold it in place. It is then slipped up into the valve proper 22, and the collar 23 is pressed into a countersink prepared for it. The valve and its stem is then set down into the casing 24, which, in turn, is set down into a hole prepared for it in the main casting of the machine. The casing fits into a taper and is held down in place by the helical spring 25 which is held in compression by the cap 26, which is screwed into the main casing.

The lower end of the valve stem is fitted with a wide washer-like collar which serves as a seat for the spring 27, by which the valve is held down and in its open position.

As the speed of the turbine is increased the governor moves the sleeve 10 to the right and this acting on the lever 19, through the carbon plug lifts the valve stem and partially closes the steam passage to the turbine. Steam is admitted at *a* and follows the course indicated by the arrows to the passage *b* which leads to the nozzles. The valve consists of two pistons with the enlarged section *c*, between them. The upper piston is merely a guide, but the enlarged section *c* and the lower piston tend to close the annular openings *d* and *e* as the valve rises and so throttle or wiredraw the steam, thus holding the turbine to a constant speed.

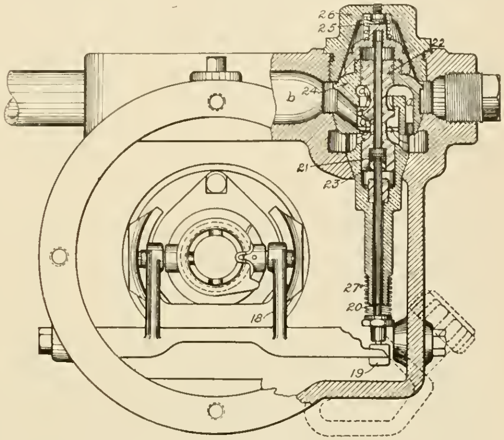
The speed is readily adjusted. The spring resistance to the movement of the governor weights is changed by an adjustment of the collar 13, by means of the tap bolts 15. This done the valve may be set in its proper position by screwing the holder of the carbon plug in or out. The plug, it will be seen is always held against the end of the sleeve 10, by the light spring 27, which holds the valve stem down against the lever 19.

Passing now to the left of the turbine the flanged hub 4, has an angle-shaped ring 28, fastened to it in the outer face of whose horizontal portion four grooves are cut for the reception of packing rings which press outwardly against a corresponding ring 29, which is held to the main casing by machine screws. This prevents any leakage of steam or water into the electrical end of the machine.

Attention is called to the ease of access which is afforded to all of the parts connected with the turbine. By the removal of the cap 30, the end is opened and direct access is obtained to the governor and valve mechanism; or, by unscrewing the cap 26, the valve can be lifted out. While, by taking out the holding tap bolts the whole end casing 31 can be taken off, exposing the turbine itself.

We next come to the space in which the main bearing is located. The base is the turbine ball bearing sleeve 32, which is pressed upon the shaft and is prevented from turning by the drive pin 33. The rotating raceway 34 is held in place against a shoulder on the sleeve by a nut 35, screwed upon the latter. The stationary raceway 36, is held by a ring 37, supported by the brackets 38, which are integral with the casing of the machine. The raceway is held in place by the bearing cap 39, which is a ring fastened to the ring 37, by tap bolts.

The sleeve bears against a shoulder on the shaft and beyond it there is a collar 40 which rotates with the shaft and carries a series of vanes, not shown in the engraving, by which the ventilation of the armature is accomplished. These vanes produce a current of air flowing from left to right through the armature and discharging into the space



Valve for Pyle-National Turbo-Generator

containing the ball bearing, from which it escapes into the atmosphere through a hole in the casing of the machine.

At this point the casing is again split, the central portion or generator yoke 41, being held to the turbine casing 42, by a row of tap bolts 43.

The generator yoke contains the armature, field magnets and coils, the coil collar also extending through it and being held in place by the armature shaft nut 50.

The laminations 51, of the pole piece are held together by pole pins 44, which are turned cylindrical from end to end with a shallow countersink at each end.

After the pin has been put in place and the pole end pieces 45, slipped over the ends, the pin is riveted over thus firmly binding the laminations together. They are also still further held by pins 46, which are run through the end pieces and laminations and riveted at the ends in the same manner.

The double cross hatched section 47, is the shunt field coil and the coarser double cross-hatched section 48, is the series field coil.

Then comes another break in the casing and the last section 69, the generator casing, is held to the yoke by the tap bolts 49. This generator casing is fitted with a door forming its upper half, which is held closed by a thumb screw, and, when raised exposes the whole of the commutator arrangement to inspection, adjustment and repair.

The commutator sleeve is made in two parts. The main sleeve 52, is a plain straight cylinder with a dovetail shoulder at the inner end and with a thread cut at the outer end for the nut 53 for holding the taper ring 54, in place. This, in turn, is threaded at the outer end for the nut 55, which holds the end taper ring 56, in place. These three rings form a complete dovetail for holding the commutator sections 58, in place, the space between being insulated with mica. The mottled sections 57, outside being the carbon brushes.

The main sleeve is held in place by the nut 59 which is screwed on the axle, and it is prevented from turning by the pin 60.

To the left of the commutator space there is a collar 61, containing two grooves in each of which there is a packing ring that has a bearing on the casing. These rings are to prevent any seepage of oil through from the outside bearing to the commutators. Then, as an additional precaution, the washer 62, is clamped against it. This washer is of a diameter larger than the outside of the lip that forms the bearing of the packing rings, so that any oil working out against it, follows its surface under the influence of the centrifugal action and is thrown off from its outer edge into the oil well 63.

The revolving raceway of the ball bearing is held in place by the nut 64, on the end of the shaft. This, then, holds the revolving raceway, and the two collars 65, and 61 with the washer 62 in place. Riding loosely on the collar 65, there is a lubricating ring 66, which dips down into the well and carries up enough oil to lubricate the ball bearing.

The fixed raceway 67, is held by the outer cap 68.

As, in accordance with the usual construction, the radius of the raceways is slightly larger than that of the balls, there is a possibility of a slight yielding of the shaft so as to adjust itself to the balance requirements of its rotation. At the same time this increase is so slight that there is practically no end play to the shaft.

With a loaded shaft revolving at the high speed at which this is run, it is essential that a practically perfect running balance should be maintained. In order that this may be effected, each revolving part is balanced separately and then after the whole has been assembled it receives its final balance which is done by drilling the nut 59.

Drainage holes are provided for each section so that any accumulated moisture or oil may be drawn off or allowed to flow out.

One of the outstanding features of the machine is the ready accessibility of all parts and, in spite of its apparent complexity, the actual simplicity of the whole structure. It may be placed either across or axially with the boiler and no trouble will be experienced from gyroscopic action as the maximum diameter of any revolving part, aside from the turbine is only 6½ in., and the turbine is only 17 in.

These generators are made in two sizes for car lighting service, that is for generating a current of 32 and 64 volts respectively. In the case of the 64-volt machine the commutator sections are so wired that an alternating current of 32 volts is drawn off for the engine lighting.

The machine illustrated is known as the type M by the manufacturers and is arranged to carry a load of 7 kilowatts 64-volt direct current for the train lighting and 500 watts 32-volts alternating current for the headlight and locomotive illumination.

Of course, with the generator placed upon the locomotive, a storage battery must be installed in each car in order to carry the load when the locomotive is detached, but these batteries can be comparatively small, and the generator has ample capacity to recharge them during the hours that it is ordinarily operated.

Foundation Brake Rigging

At a recent meeting of the Canadian Railway Club, W. H. Clegg, chief air brake inspector of the Canadian National Railway, presented a paper in which he criticized the average design of the foundation brake rigging on locomotives, because of the unnecessary variation in the dimensions of the details.

He presented drawings of the rigging on three types of heavy locomotives in which these variations were emphasized. In one case, that of a mikado locomotive four sizes of brake beams were used, and two sizes of brake beam bearings. In another case, there were again four sizes of beams and two diameters of hanger pins. And similar variations were set forth in a third design.

In contrast to this he showed a design used on the Canadian National in which there was but one size of beam, and all beam bearings and hanger pins were of one dimension respectively.

Not only does this uniformity greatly facilitate the making of repairs, but the additional stock needed where there is a difference of dimension, requires more in the way of brake parts that the stores department must carry, and this is such an important factor affecting the investment that it cannot be ignored.

In connection with the rigging on freight cars the paper included an analysis of the distribution of cylinder power as follows:

14-inch brake cylinder. Estimated power and at full efficiency	9,236 lbs.
Total leaverage	10 to 1 "
Estimated breaking power, emergency application	92,360 "
Loss due to packing leather friction	275 "
Loss due to cylinder release spring tension (8-in. travel.)	700 "
Loss at piston rod to move levers on car body	250 "
Loss at piston rod to move levers on car trucks	200 "
Total loss at piston rod	1,425 "
Estimated efficiency of cylinder	9,236 "
Deduct total loss at piston rod	1,425 "
Leaves the actual value of cylinder	7,811 "
Times the total leaverage, 10, makes the pressure on brake beams	78,110 "
Less brake beam release spring tension (12 springs)	2,400 "
Leaves actual braking power delivered	75,710 "
Total loss from all sources	16,650 "
Per cent of loss	18 P.C.
Per cent of efficiency	82 P.C.
Per cent of total loss, due to brake beam release springs	14.41 P.C.
Per cent of total loss, due to all other causes	85.59 P.C.

In the course of the discussion the advantages accruing from the disuse of the breakbeam release springs on passenger equipment was developed. It was stated that it was found from dynamometer car readings, in the case of the Lake Shore Railway Toledo brake tests, that it required a drawbar pull of 8,370 lbs. to maintain a speed of 60 miles per hour with a ten-car twelve-wheel car train when standing brake cylinder piston travel was adjusted at 6 inches, while with the same train and speed only 6,200 lbs. drawbar pull was required when standing piston travel was increased to 7 inches, indicating in the first instance a loss of 35 per cent in the available effort of the locomotive due to some brake shoes rubbing the wheels.

In the words of the Committee this was one of the most useful bits of information that came out during these exhaustive tests, and resulted in the prompt adoption by many railways of the clasp type of foundation brake gear, which construction permits of a standing piston travel of close to 8 in.

In connection with a discussion of the variables that exist in foundation brake installations and maintenance it has been found that with a co-efficient rail friction of 25 per cent and a combined brake rigging efficiency and brake shoe co-efficient of 5 per cent, a braking ratio of 500 per cent of the light weight car can be employed without excessive wheel sliding, while with the co-efficient of rail friction of 25 per cent and a combined brake rigging efficiency and brake shoe co-efficient of 25 per cent, only 100 per cent braking ratio can safely be employed if wheel sliding is to be avoided, and further, using 60 miles per hour as a basic speed and 1,000 feet as a basis for length of stop, it has been shown that a 20 per cent reduction in braking ratio will increase the length of stop 24 per cent and similarly a 20 per cent decrease in the efficiency factor increases the length of stop 24 per cent. In contrast of this, a 5 per cent increase in speed only increases length of stop 10 per cent and a 1 per cent descending grade increases length of stop only 8 per cent.

Work Required of Draft Rigging

The accompanying diagram indicates the amount of energy to be absorbed or transmitted by the draft gear of a car, on the basis of its own complete rigidity. It will be reduced somewhat by an amount depending upon the resilience of the car structure and the ability of the lading to shift. The energy also varies, as shown by the diagram, according to the condition of the body with which the car comes into contact.

This is shown by the lines 1, 2 and 3 at the bottom of the diagram. For example, according to these lines, No. 1 indicates that the energy to be absorbed when the car runs against a solid abutment at a speed of three miles per hour is equivalent to six miles an hour when striking against a stationary car having its brakes set or about 5⅓ miles per hour striking against a number of standing cars in an approximation to service conditions.

The other heavy horizontal lines just below the lines of 5,000 and 15,000 ft. lbs. of energy show the absorbing capacity of draft gears, made up of one 6¼ in. by 8 in. spring; two 6¼ in. by 8 in. springs; two class G springs and a friction draft gear respectively.

These show an absorption capacity of 2,000, 4,000, 5,000 and 13,000 ft. lbs. of energy respectively.

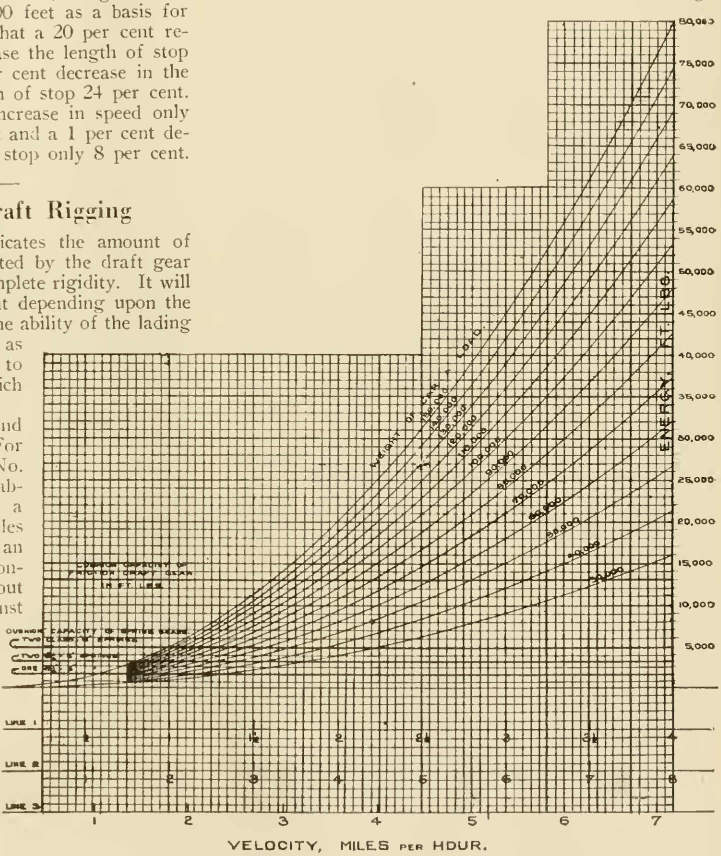


Diagram Indicating Energy Absorbed or Transmitted by Draft Gears

The curves show the energy developed by cars of varying total weights, rising from 30,000 lbs. to 150,000 lbs. by increments of 10,000 lbs.

Thus a car weighing 150,000 lbs. striking against a solid abutment at a speed of 3 miles per hour, would require the absorption of 45,000 ft. lbs. of energy. While for the same speed striking a stationary car with the brakes set, an absorption of only about 12,500 ft. lbs. of energy would be required.

The diagram was worked out by Mr. Richard D. Gallagher, Jr.

Supply Exhibit for Boiler Makers' Convention

The Boiler Makers' Supply Men's Association have announced the completion of arrangements for exhibits in connection with the Master Boiler Makers' Convention which will be held at the Sherman Hotel, Chicago, Ill., May 19th to 22nd.

The annual convention of the International Railway Fuel Association will be held exactly in the same place on May 25-28 inclusive, so that supply men exhibiting at both conventions can secure the same exhibit space, if they so desire, and allow their exhibit to stay in place from May 19th to 28th.

The convention is attended by prominent railroad master boiler makers, foremen boiler makers, and a large number of master mechanics. Railway supply manufacturers interested in this opportunity to meet the boiler makers and exhibit their products to such railroad men should make application for membership and exhibit space to W. H. Dangel, Secretary, Boiler Makers' Supply Men's Association, care Lovejoy Tool Works, Chicago, Ill.

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The Railroad and the Motor Car

A recent issue of the *Atlantic Monthly* contains an article by Judge George W. Anderson of the Circuit Court of Massachusetts on the relations of the railroad to the motor truck. Judge Anderson analyzes the situation, discusses the equity of the case and is impartially free with his criticisms of railroad managements and motor truck operations. In his first section he calls attention to the investment of about $20,000,000,000 in the railroad industry, which includes not only the railroads themselves, but the locomotive, and car-building concerns and the allied industries. This is met by the total investments in the country in automobiles and motor roads, which he places at approximately $22,000,000,000.

He estimates that the railroad passenger cars have a seating capacity for about 2,250,000 people, while the automobiles have a seating capacity of 70,000,000 or about thirty times the seating capacity of our railroad cars. We could move two-thirds of our population of 110,000,000 at one time, thirty miles an hour on very good roads from coast to coast. As carriers of mankind, the automobile has already passed the rail carrier.

"Turning from passenger traffic to freight movement, the encroachment on railroad traffic measured by tons is not alarming. Measured by its importance and potency for profit, it is serious. Apart from the privately owned and operated motor equipment, we have a rapidly increasing number of lines of public motor transportation concerns, moving in competition with each other and with the rail lines all over the country. This movement is, to a large degree seasonal; and the competition with the rail lines is grossly unfair. We cannot justify a public policy that permits road-destroying trucks, moving over free rights of way to take the cream of the business in the most favorable season, remitting the rail lines to an unremunerative, but enforced, service in bad weather—while we compel the rail lines to pay exorbitant taxes, which go in substantial part to create the free roads on which trucking concerns, frequently financially irresponsible, carry, damage or lose goods."

It is pretty clear that much of the trucking business is now parasitic; that it pays taxes disproportionate to its road-destroying achievements; and that it calls for such regulation as will greatly reduce its unfair seasonal competition with regular reliable transportation service.

He called attention to the fact that on a railroad the vehicle is steered by the road and that the motor is not steered but is dependent upon its driver. In connection with the drivers of the two machines, he speaks of the locomotive engineers as a hightly trained and experienced class whose functions are to start, control the speed of and stop their engines. Except that they must observe switches and signals they have no steering to do. Their highway does the steering. But the driver of a motor vehicle must not only start, control the speed and stop but must steer his vehicle with reference to all the curves and obstacles in the highways as well as with reference to the steerers of like motor vehicles.

But, instead of having on our non-steering roads only a carefully selected and experienced set of trained men, we have millions of engineers of both sexes, some of them frequently drunk, a considerable part of them financially irresponsible. The result is inevitable.

Compare the achievements of the railroads with those of motor cars in the killing and maiming field. In 1923 the railroads killed 7,385 and injured 171,712 people. In 1924 the fatal automobile accidents were not less than 17,000 and in addition about 500,000 persons were injured.

The general conclusion is that motor traffic is unsafe, unpleasant and generally undesirable unless kept within moderate limits. We are now at or near the saturation stage.

The conclusion is reached after a recognition of the fact that the motor industry has outgrown that of the railroads, that the railroads show many signs of decaying old age.

Exception will, however, probably, be taken to the statement that there has been no substantial improvement in railroad equipment or management in twenty years or more. The actual abandonment of about 4,000 miles discloses but a small part of the discouraging facts shown by an examination of train schedules and other indicia of the decadent condition of the thin lines. While we have tens of thousands of miles of railroads that ought never to have been built, few of them should be abandoned. Our railroads need an intelligent conservation program as much as do our forests.

The situation is critically bad and rapidly growing worse. But this junking proposition should not be accepted without a struggle to avoid such an appalling waste.

Railway Management's Problem

Elsewhere in this issue will be found the paper read by Mr. Julius Kruttschnitt, Chairman of the Executive Committee of the Southern Pacific Company, entitled "The Engineer as an Executive," which he read before the New York Sections of the principal engineering societies of the Metropolitan district.

Owing to the length of the paper and the limited space available, it is to be published in two sections, the first in the present issue and the second half in our issue for May.

Mr. Kruttschnitt's paper contains an unusual amount of valuable and instructive information in such matters as railway location, type and design of motive power, relative value of various kinds of fuel, and economies from operation, all of which come within the purview of the chief officer in charge of a railway, and which calls for the highest type of engineer executive and of which the author is an excellent example.

An interesting feature is the graphic chart which displays the enormous increase in unit costs of labor and material during the past decade, and which reflects that the increased rates on railway traffic has not kept pace with these increases in operating costs. Thus, it has become more difficult each year to so operate a railway property as to avoid a deficit; while the average return is entirely too low to invite new capital to the railway field.

The chart referred to will be found on page 104 of this issue of Railway and Locomotive Engineering, and we commend our readers who are interested in a true picture of the railway situation to study it carefully.

The cost of labor increased 200 per cent during the war period and is at present 47.99 per cent of each dollar which the railroads receive. While material prices and labor costs have receded from the peak of 1920, both are still so high as to leave most lines a very narrow margin of profit after meeting fixed obligations. Many roads less fortunately situated have barely escaped receivership. While it is true that freight and passenger rates were increased about 40 per cent during the period under consideration, it will be noted that this did not provide proportionately for the increase in railway expenses. Hence, there is a very narrow spread between "the cost to produce" and "the selling price of transportation."

The Growth of Railroad Safety

The steady growth of safety on the American railroads is emphasized by the accident report of the Interstate Commerce Commission just issued for the month of December, 1924, and for the year 1924 as a whole.

In 1924 there were 22,368 train accidents against 27,497 in 1923. In the accidents in 1924 only 367 persons were killed against 412 in the accidents in 1923. Persons injured in 1924 amounted to 3,986 against 5,158 in 1923.

In 1924, passengers killed totaled 41 and those injured 2,125 as against 42 passengers killed and 2,662 injured in 1923.

In December, 1924, ten million locomotive miles were run before a passenger was killed and over 400,000 locomotive miles were run before a passenger was injured.

There were also 119 fewer fatalities from grade crossing accidents in 1924 than in 1923. Last year 2,149 people were killed at grade crossings and 2,268 the year before.

Of the total number of persons killed in 1924 about 32 per cent and in 1923 about 30 per cent were due to accidents at grade crossings.

The increase in the percentage of grade crossing fatalities to the total number killed in 1924 as compared with 1923—in spite of the fact that there were fewer fatalities at grade crossings in 1924—was due to the reductions in almost all other kinds of railway fatalities. From the report of the Interstate Commerce Commission these were as follows:

	Killed	
Train Accidents	1924	1923
Collisions	109	134
Derailments	181	215
Locomotive-boiler accidents	25	43
Other locomotive accidents	...	...
Miscellaneous	52	20
Total	367	412
Train Service Accidents	1924	1923
Coupling or uncoupling cars or locomotives	72	103
Coupling or uncoupling air hose	21	27
Operating locomotives	20	31
Operating hand brakes	34	24
Operating switches	3	1
Coming in contact with fixed structures	63	69
Getting on or off cars or locomotives	495	539
Accidents at highway grade crossings	2,088	2,246
Struck or run over, not at pubiic crossings	2,333	2,618
Miscellaneous	719	852
Total	5,848	6,510
Total—Train and Train-Service Accidents	6,215	6,922
Grand Total—Accidents of all Classes	6,617	7,385
Total Casualties at Highway Grade Crossings	2,149	2,268

Preserve Rate Making Power of I. C. C.

Representative business interests throughout the country are to be appealed to through the Chamber of Commerce of the United States to block any move on the part of Congress to usurp the rate-making authority now invested in the Interstate Commerce Commission by law.

"The attempt by Congress to legislate upon such matters is a menace to constructive regulation and opens the way for congressional action on all rate questions," is the wording of the resolution approved by the Chicago Board of Trade for presentation to the National Chamber.

"The movement will tend to upset and abolish all existing freight differentials by tossing these problems of scientific study and adjustment into the congressional arena, where they will be viewed strictly from the standpoint of political expediency."

The resolution cites in part that "whereas, with no reflection upon Congress, its conclusions must be more or less controlled by local influences, rendering such decisions most dangerous to the transportation interests of the country; therefore be it 'Resolved, that the Chamber of Commerce of the United States protests against the enactment of all laws encroaching upon the rate-making authority of the Interstate Commerce Commission as provided by law.' "

I. C. C. Needs Attorneys and Examiners for Valuation Work

To complete the valuation of the property of railroads, recently authorized by Congress, the Interstate Commerce Commission will need a considerable number of attorneys and examiners for all grades of positions, requiring legal training and varying degrees of legal experience, it is said in a notice of the United States Civil Service Commission issued recently.

Lawyers with experience acquired in litigation involving matters concerning the regulation of common carriers or other public utilities are especially desired by the Interstate Commerce Commission.

Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or the secretary of the U. S. civil service board at the post office or customhouse in any city. The receipt of applications will close on April 21 for some of the positions, and on April 25 for others.

Facilities for Fuel Oil for Locomotives

Report of Sub-Committee on Shops and Locomotive Terminals Presented at the 26th Annual Convention of the American Railway Engineering Association March 10-12

The presence of some fire risk in connection with any handling of an inflammable liquid such as fuel oil must be recognized. This risk extends not only to the oil itself and the facilities for handling it, but to adjoining property which may be exposed to danger from a fire in connection with the oil facilities. These facilities must be so designed as to keep the fire risk at a minimum, consistent with economical construction and operation. The extent of the risk and the design of these facilities with a view to reducing it will depend, to some extent, upon the character of the oil to be handled, its flash point, and the proportion of the lighter and more volatile constituents remaining in it.

After further consideration the committee does not agree with the criticism that the unloading trough or box between the rails, recommended in its previous report, increases the fire risk. The use of a pipe connection from the tank car outlet, as mentioned in the former report, has been found cumbersome and awkward, and likely to result in loss of oil due to defective outlet valve. The use of other than a tight pipe connection, such as the movable trough, attachable to the outlet and leading to a sump outside the rails, appears also to be somewhat less satisfactory from the standpoint of avoiding the loss and fire risk resulting from wastage of oil. No serious difficulties are reported by the roads using the troughs and boxes, in the matter of supporting the track over the unloading facilities. One method of such support was illustrated on page 80 of vol. 25 of the proceedings. Sketches showing variations in use by other roads are submitted herewith. The following quotations from representatives of two of the roads having longest experience in the use of fuel oil appear to the committee to be in point:

"Relative to the matter of unloading arrangements, we have tried several different kinds, but found that the troughs between the rails give us the best satisfaction from the standpoint of unloading the oil, and also making it possible to keep a cleaner condition around the unloading track. However, we have adopted the policy of using the method of unloading that would best suit the station, which in turn was governed largely by the quantity of oil to be unloaded."

"We are now building unloading sumps in center of track. We have never had any trouble with these sumps, and consider them easier to use than the sump alongside track where it is necessary to use a trough from the tank discharge pipe to the sump. The center sumps must be thoroughly constructed, preferably of concrete, and with suitable cover. The old style wooden sump with plank cover is a bad nuisance and a fire hazard, and should never be built."

The point of view of another company is set forth in the following quotation:

"The first method of unloading oil was to construct between the rails, track sumps either of concrete or wood, which received the oil directly from the tank car, pipe leading from bottom of pit to some style of sump. These open pits are objectionable, both from a fire hazard point of view, and the fact that they always present a very dirty and untidy condition. In place thereof, we developed a side-unloader.

"The advantage of this system is that section foreman can always maintain his track in standard manner with clean ballast. The unloading pipes are all underground and the only exposure of pits consists of small manholes which can always be properly covered, and present a clean appearance. The troughs leading from the tanks to the manholes, when not in use, can be neatly stored and kept reasonably clean by the pumper.

"However, as there seems to be a demand for unloading devices in the center of track we have prepared a new design for such a type which eliminates all objections to the open pit. This design incorporates a small center track pit with a metal cover conencted to the main receiving sump with a pipe in which an oil barrier is created which prevents the escape of gases from the main sump."

Ordinarily, the track used for unloading oil should not be used for any other purpose. The committee has revised its recommendation to include this provision, and one for the use of metal covers on unloading troughs or boxes, and with these changes stands on its former conclusion as recommended practice for inclusion in the Manual.

The committee's recommendation that each storage tank "should be surrounded by an earth dike enclosing below the elevation of top of dike a volume equal to one and one-half times the capacity of the tank" was based on the regulations of the National Board of Fire Underwriters for the storage and use of fuel oils. These regulations provide that

"In locations where above ground tanks are liable (in case of leakage or overflow) to endanger surrounding property, each tank shall be protected by an embankment or dike.

"Such protection shall have a capacity of not less than 1½ times the capacity of the tank surrounded, and shall be at least four ft. high, but in no case higher than ¼ the height of tank when height of tank exceeds 16 ft.

"Embankments or dikes shall be made of earthwork or approved concrete. Earthwork embankments shall be firmly and compactly built of good earth, from which stones, vegetable matter, etc., have been removed, and shall have a flat section at top of not less than three feet and a slope of at least two to one on both sides.

"Embankments or dikes shall be continuous with no openings for piping or roadway. Piping shall preferably be laid over or under embankment."

The following quotations from letters from oil using roads are of value in this connection:

"As to the matter of fire walls, I have found that this is often covered by ordinance, and I believe that our recommendations for 1½ times the capacity of the tank is pretty generally the one that is adopted. There is one question, however, that I am not sure we covered, and that is, the distance from the tank that the fire wall is placed. This is also a question as to whether we wish the fire walls to protect the fuel oil tank or to protect the oil from flowing over the adjacent tanks or buildings.

"To illustrate what I mean, at one point we have the fire wall around the tank within about 25 or 30 ft. from the circumference, and have also placed an additional fire wall some 150 ft. from the first fire wall, which is intended to catch the flying spray from the burning tank and prevent it from flowing into our roundhouse building.

"I believe that our recommendation on fire walls should stand. We might add that secondary fire walls should be provided if it is desired to protect other property and that they should be placed as far from the tank as is permissible."

"As to capacity of levee—I endeavored to develop best practices through correspondence with various people and fine that levees were being constructed to provide from 1.1 to 1.5 capacity of tank enclosed (think in a general way the fire underwriters prefer 1.5 capacity). However, I have never been able to develop any conclusive evidence pointing to the necessity for 1.5. Our experience points to the fact that when a fuel oil tank gets on fire the oil burns for a very considerable time before there is any rupture of steel, and that almost invariably the steel shell collapses inwardly rather than outwardly. Oil burns up at the rate of six inches per hour so that the volume of oil is rapidly decreasing as the fire burns. Even assuming a quick rupture of a full tank there would only be a surge of comparatively a small amount of oil over top of levee, the rest of it would be held in check while consumed by fire. Given unlimited space with earth formation, of course, there is no particular objection to building a levee of 1.5 capacity, but usually around shop grounds the space is limited and bank material expensive. Therefore, would regret to see a rull promulgated demanding the maximum.

"In my judgment with the floating roof there is no necessity of a levee except as an extra precaution where very valuable property is exposed."

"At practically all of our storage tanks we have ample room for the construction of levees, and are following a consistent practice of maintaining these levees to a sufficient height and diameter to retain at least one and one-third the capacity of the tank. We have recently spent quite a sum in bringing our levees up to this standard. It is necessary to take into account not only the actual capacity of the tank, but the waves and swelling of the oil which will take place in case a burning tank boils over, which will sometimes raise the oil as much as two feet higher at the levee than it would otherwise be."

Pending further development and experience with tank rooms designed to eliminate fire risk, the committee feels that the provision for capacity within fire walls set up in its former conclusion represents the desirable condition to which, as nearly as may be practicable, construction should conform.

The practice of the larger oil companies tend increasingly toward the use of all-steel vapor-tight roofs on permanent installations of large storage tanks. The loss, through evaporation, of valuable elements from the oil, as well as the danger of fire, caused, either by lighting or by the burning of other structures in the vicinity, is materially reduced by this practice, especially where the oil contains considerable quantities of the more volatile constituents. The residuum in general use as fuel oil, from which the lighter elements have been extracted by refining, is less subject to loss through evaporation, as well as less readily inflammable. While some roads have experienced loss by fire, and have gone, or are going, wholly to the use of the vapor-tight roofs, many, after years of experience, are still using the wood sheathed roofs, and feel that, in view of the class of oil they are using and the uncertainty as to the length of time for which a supply of fuel oil will be available, they are not justified in incurring the additional expense for the steel roofs.

Two or more types of tanks with floating roofs, said to eliminate, wholly, both loss by evaporation and danger of fire from any cause outside the tank, are now being manufactured, and are being tried out experimentally by some of the oil companies and by at least one railroad. They are still more expensive than the steel roofs, and would apparently be of value chiefly for the storage of the more volatile and inflammable oils.

The experience of some of the railroads with different types of roof, and their present practice and recommendations are outlined in the following statement:

"Our losses of stored fuel oil have not been very serious in proportion to the large amount of fuel stored. In December, 1919, a 37,000-barrel storage tank was partially destroyed by fire, which originated in burning grass and weeds adjacent to the tank, the heat or flames probably communicating with gases present near the roof. In September, 1923, a 55,000-barrel storage tank, one of a group of eight, was totally destroyed by fire after being struck by lightning.

"Practically all of our large tanks are equipped with steam smothering lines around the inside of the tank near the top.

"Chief engineer of a large oil company advised me that after considerable study they have adopted as standard a gas-tight steel roof, supported on steel frame work inside of tank, fitted with several automatic opening and closing gas-tight hatches for relieving gas pressure; also states they did not consider the floating roof very practicable, and did not intend to use it.

"Chief engineer of .... (another oil company), advised me they are installing gas-tight steel roofs, and consider them the safest roof which can be built. They are also installing one of the floating roofs, as an experiment. This company uses wooden roofs on temporary tanks, and steel roofs on permanent tanks.

"........... (another oil company) follow the same policy, and are also considering installation of breather pipe leading out through the levee.

"Our standard roof construction has heretofore been wood frame-work and sheathing covered with tar and the additional cost of gas-tight steel roof is warranted for permanent storage."

"We recently had some experience with tank being struck by lightning, a 55,000-barrel tank having been recently struck in a thunder storm during the night. The tank was practically full of Mexican oil. It was covered with tar and gravel roof. Fire started in the roof; the oil was promptly flooded with live steam through pipes provided for that purpose, and fire was soon extinguished without doing more damage than charring a few of the roof sheathing boards, and without having touched the oil in the tank at all. This is the first case of which we have any record of fire on or near one of these tanks. We are storing something like one and a half million barrels of oil, including both domestic fuel oil and Mexican oil."

"We had a 55,000-barrel tank destroyed by fire about four years ago. The fire first started in our coal chute, located some 1,200 feet away from the storage tank. Although the oil tank was not directly in the course of the wind from the burning coal chute it did catch fire, due to the ignition of gases in the tank.

"The tank was constructed with a frame roof covered with sheet iron, and it was the consensus of opinion of those fighting this fire that it was caused from the gases leaking around the edges of the tank. In rebuilding this tank, and other tanks later, we used entire steel roofs."

"Regarding the matter of tank roofs, this depends somewhat on the nature of the fuel oil that is being handled. Oil companies handling crude oil have a different condition than the railroads that handle only fuel oil. If the gasoline content has been removed from the oil, the danger of the tanks being struck by lightning, igniting the gases is greatly reduced. We have handled fuel oil since 1900, and I attribute the fact that we have had no losses due to fires to the fact that we used for a great many years the topped light domestic oil; and I am sure the vapors given off by the oil were practically nil. In the last few years, however, we have begun to use Mexican crude, which has a very small per cent of gasoline content; although the trouble with the oil is that the gasoline is pocketed in the oil and is very treacherous from a standpoint of giving off gasses. For that reason, some time ago I recommended that we equip a few of our fuel oil tanks with air-tight roofs. This was not because we wished to protect the fuel oil so much as it was to protect the roundhouse buildings that were close by. At this time I looked into the matter very extensively, and found that the air-tight roof was by no means a complete safeguard against being struck by lightning.

"I think the character of tank roof should depend upon the nature of the fuel oil to be handled. If it is crude oil, containing gasoline content, I believe the gas-proof roofs with explosion hatches, etc., should be recommended."

"Our reasons for adopting the floating roof as one of our fireproof types are as follows:

"1. Failure of storage tanks have resulted from (a) roof fires which have ignited oil in tanks; (b) fires from external sources which have caused the explosion of gases collected under the roofs. Both of these hazards are eliminated in the floating roof, which is of steel; no gases can collect under it and no external fire can reach the oil.

"2. Elimination of the above hazards justifies the elimination of the safety levee around the tank. This makes it possible to build the plant in a smaller area and to improve existing plants built on limited areas.

"3. The saving in area and the cost of the levee off-sets the cost of the floating roof.

"We have installed six such roofs on large tanks, and they are working successfully."

Air-Lift Delivery

An interesting variation from the usual delivery methods for use at small stations is described in the following quotation:

"There are many small stations where continuous automatic pumping facilities cannot be provided, and to cover this situation an oil air-lift facility has been designed. It incorporates well known principles already applied to the handling of liquids with air; the operation is briefly described as follows:

"One of the air holes is connected with the locomotive air supply, the air is forced through the foot-piece at the bottom of the eduction pipe and in rising, completely aerates the oil in that pipe; the presence of air in the eduction pipe reduces the density of the liquid below that of the oil in the outer casing and sump and forms an emulsion which must rise to a higher level than the oil in the sump to establish equilibrium. In doing this the aerated oil enters the booster tank, where the air is liberated from the oil; sufficient air pressure is retained in the booster tank to force the incoming oil through the outlet pipe to the oil column; the excess air above that required to deliver the oil to the oil column is liberated through a relief valve at the top of the booster tank.

"This facility incorporates no moving or mechanical parts and hence requires no attention from an operator, and practically no maintainance the oil supply is all underground, delivery at the column stops instantly the air is shut off (or the outlet valve closed) and hence no fire hazard exists from oil under pressure or from leakage while the facility is standing idle. The air to operate may be furnished by the locomotive itself, hence the system lends itself readily for small wayside stations."

Concrete Storage Tanks

Some of the oil companies report successful use of concrete tanks for large storage of inert fuel oil. So far as the committee's investigation has gone, such use has not been taken up to any extent by the oil using railroads, practically all of which use and recommend the steel tanks for such storage, though several use concrete for small service and sump tanks, especially where such tanks are underground.

1. Where oil is used as fuel for locomotives the facilities required include provision for unloading it from cars, for holding it in storage, and for delivering it to locomotive tenders.

2. The details of design necessarily vary with the composition and gravity of the oil to be used and the climatic conditions to be encountered, as they affect the temperature which must be maintained in the oil for convenient handling.

3. Oil should be unloaded from tank cars by discharging direct into a trough, or boxes of steel or concrete between the rails of track on which cars stand for unloading. Where boxes are used, they should be spaced at car length intervals for convenience in spotting cars for unloading. Troughs or boxes should be equipped with metal covers, kept closed when not in use. The unloading facilities should be located on a track assigned for this purpose, and so that it will be unnecessary for locomotives to pass over them.

4. Unloading trough or boxes should deliver oil by gravity through pipe line to depressed sump from which it may be pumped to storage or delivery tank. Such pipe line should be of sufficient size, and be laid with sufficient gradient so that oil will flow by gravity to the sump as fast as it will be discharged from the total number of cars which can be operated at any time. This should not be in excess of the capacity of the pumps.

5. Sumps may be of steel or reinforced concrete, and should be covered. They should have capacity of not less than one carload. If of steel, the pit should be drained, or the sump should be anchored to prevent displacement by ground water when empty. The sump should be vented to draw off gases generated by heating oil in the sump tank, and in some circumstances it may be desirable to install an oil trap or barrier in the pipe line leading from the sump to the track trough or box to prevent the flow of gases from the sump to the track trough or box.

6. The storage capacity which should be provided depends largely upon reliability and source of supply and probable variations in market price of oil. In general, there should be at each station sufficient storage to protect against any interruption which may occur in the delivery from the regular source of supply. Additional storage for the purpose of taking advantage of variations in market conditions may either be located at various terminals where oil is used, or concentrated at one conveniently located point.

7. Cylindrical steel tanks of 55,000 and 80,000 barrels capacity, erected on leveled earth foundations, provide convenient and economical storage, and can commonly be secured promptly and at less cost on account of being standard construction with tank manufacturers. Roofs should be provided of steel or of wooden frame and sheathing, covered with asbestos, composition, tar and gravel, or sheet metal roofing. In permanent installations, or where oil having large gasoline content is to be handled, gas-tight steel roofs equipped with breather pipes with outlets outside the dike, and floating roofs have the advantage of reducing evaporation of gases, and danger of fire. Each tank should be surrounded by an earth dike, enclosing below the elevation of top of dike a volume equal to 1½ times the capacity of the tank.

8. Adequate means should be provided for the escape of gases thrown off from the surface of the oil. The character and extent of such provision required will depend on the tightness of the roof and the character of the oil. It should be designed to reduce circulation of air over the surface of the oil to a minimum consistent with

prevention of building up of pressure due to the accumulation of gases.

9. Provision should be made for draining off water and refuse which may settle in the bottom of tanks.

10. Oil may be delivered to locomotive tenders by gravity from elevated steel tanks or under direct pump pressure. In general the former method is more convenient and economical. If the gravity system is used, particular attention should be given to the introduction and proper location of cut-off valves in the delivery lines, so that the flow of oil from the tanks can be immediately controlled.

11. The size of delivery tank required varies with local conditions, as to receipt and handling of oil, but the capacity should, in general, be not less than the average amount of oil to be delivered in twenty-four hours.

12. Valves should be provided for draining off water and refuse which may accumulate in the bottom of tanks.

13. Delivery columns should be so constructed that spout can be swung to position and valve opened from the locomotive tender to be served. Spouts should have maximum freedom of movement in both horizontal and vertical directions, consistent with prevehtion of leakage. They should be provided with drip buckets, reversible end elbow, or other means to prevent drip.

14. Means should be provided for measuring accurately deliveries of oil. Meters in delivery pipe lines or gauges or engine tenders serve satisfactorily to that end.

15. Some wastage of oil around an engine terminal is inevitable and provision which will reduce such wastage to a minimum is an important item in design of facilities for handling oil. If all unnesessary waste and leakage is eliminated the cost of recovery of waste oil is generally in excess of the value of the oil. In cases where such waste is excessive or becomes a nuisance, however, and causes damage to neighboring property, it becomes necessary to provide traps in drainage channels or sewers, equipped with baffles, to catch the waste oil, separate it from water, and permit its recovery by dipping or pumping back to the pump. Such appliances are being used successfully.

Heating

16. Where heavy oil is used or where cold temperatures are experienced, it is necessary to provide means for heating oil in cars, tanks and pipe lines, in order that it may flow freely. Such heat is best provided by steam pipes.

17. Pipe coils in tank cars, which can be readily connected by flexible hose or pipe to steam pipe lines from the pump house, provide satisfactory means for heating before unloading. The discharge of live steam directly into the oil in the can may be resorted to in case heating coils are out of order or car is not equipped.

18. Similar steam pipe coils provide satisfactory heat for storage and delivery tanks. In larger tanks they are more effective if enclosed with the end of the discharge line leading from the tank in a wood box so that the heat will be applied directly to the oil as it leaves the tank, and not disseminated through the whole tank full of oil. The heating of oil in pipe lines will often prove advantageous and may be accomplished by introduction of small steam line inside an insulating box alongside the oil line. The latter method simplifies construction and maintenance, but requires more expensive first installation and greater consumption of steam in proportion to the results obtained.

19. Where steam lines are installed in oil lines, it is necessary to take precaution against excessive heating. On this account, it is not recommended that steam lines so installed be larger than necessary for heating the pipe line. Steam for tank coils and other purposes may better be carried outside the oil lines.

Small Stations

20. While the foregoing recommendations apply primarily to the larger stations, yet the general principles apply to the small stations except that their application requires special adaptation to the problem. In some cases, the oil is used direct from the cars; in other cases, storage from one or more cars is combined with delivery tanks, delivery being made either by gravity, pumps or air pressure.

German Railway System Now the Largest in the World

One third of the payments that Germany has agreed to make on account of reparations are to be derived from her railways. This, and the fact that the unification of the German Railway System make its organization, earning power, and in other details the largest system in the world, is of unusual interest.

Before the World War the German railways, with unimportant exceptions, belonged to the several states. The roads had a large earning power, and contributed to an important extent to state revenues, and in this way to the reduction of taxation.

When the war came the railways of the separate German states had long been nationalized. Prussia with five-eights of the total mileage had the lion's share of the transportation facilities of Germany, and consolidation was not attempted until 1920. In that year, under the Weimer Constitution, the several states handed over their railways to the Reich.

In November of 1923, when, owing to the collapse of the mark, the expenditure of the railways was seven-fold greater than their receipts, the German Government was unable to finance them further and left them to stand on their own feet. A scheme for a separate undertaking under the management of the state was promulgated in the following February. But within a few weeks came the publication of the Experts' Record, finding that maximum earnings could be obtained only if the roads were operated as a unit, and recommending the transfer of the railways to a commercial company. So the separate undertaking of February perished six months later, in August, 1924.

33,000 Miles of Centralized Railways

The new German Railway Company—officially designated the Deutsche Reichsbahn Gesellschaft—which has already taken over the actual working of all the German railways, with negligible exceptions, is much the largest railway undertaking in the world. It employs 750,000 men and operates 33,000 miles of line—half as many again as the next longest system, the Canadian National. Its nominal capitalization of about $6,200,000,000 is far and away the largest. Its annual receipts of over $1,000,000,000 are not far from double that of its nearest rival, the Pennsylvania Railroad.

Actual value of the properties owned by the German railway company is "at least as great as the capitalization fixed for the company," according to the experts. The total valuation of $6,200,000,000 represents a unit value of $200,000 per mile. This unit value compares favorably with that of the railroads in neighboring countries, and it is being increased constantly by capital betterments.

Equipment Is Adequate

With regard to the condition of equipment of the railways, Sir William Acworth and M. Leverve reported to the Committee of Experts as follows: "The railways have not merely been restored to their pre-war state of efficiency, but have been brought up to a much higher standard, a standard which, to the best of our knowledge, is superior to that of any other country." According to advices received from experts, capital has been spent on the German Railways so freely that no serious new capital expenditure need be incurred for some years to come. For instance, two-thirds of all the rolling stock is less than ten years old.

Rolling stock before and since the war is compared in the following table:

	1913	1924
Locomotives	27,690	30,500
Passenger Cars	61,276	67,800
Freight and Baggage Cars	631,323	723,100
Total	720,289	821,400

It may be seen that while there has been no increase in mileage of the railways, the increase in rolling equipment is 14 per cent. Figures for 1913 include all portions of the railway system lost since the war, with the exception of the railways of Alsace-Lorraine. If the portions lost were excluded from the 1913 figures, the increase in rolling stock would appear even larger.

At the time when the 1924 figures on rolling stock were compiled, there were still outstanding orders for 25,653 freight and baggage cars, 1,453 passenger cars, 884 steam locomotives and a quantity of electric locomotives.

At the same time the expenditure on fixed capital account has been greater than was necessary or even justified. The special committee reporting to the First Experts Committee stated that German officials "regarded it as due to the dignity of the German Reich that buildings should be magnificent, that railway plant should be up to a very high standard, that such and such services should be given, and so on. They had never been taught the commercial necessity of cutting their coat according to their cloth."

Rate Structure Now Revised

Tariffs until very recently were kept low, especially for passengers. The guiding principle, as expressed by Doctor Sarter, a highly placed official in the transport ministry, was: "The state railways ought primarily to have regard to the progressive development of the economic life of the country and to treat the attainment of net revenue as only of secondary importance."

Especial emphasis has been laid upon the fact that the railways are now being operated "on a business basis" and are wholly self-supporting. In the language of the Act putting into effect the agreements expressed in the London Protocols, the statement is made that "the Company is to be operated on a business basis, taking into consideration as well the economic interests of the country." As now established, the rates for passenger and freight transportation are higher than rates for comparable services in the United States, as will be seen from the following:

Rates on German Railway

	Cents per Mile
Passenger:	
First Class	3.86
Second Class	2.54
Third Class	1.73
Fourth Class	1.15
Freight:	
Average per Ton	1.73

Admittedly "the mere transference of the railways from State to company management will not of itself alter this mental attitude" of giving secondary importance to the attainment of net revenue. Therefore the position of railway commissioner, representing the Allies, was created to enforce the maintenance of rates that would bring a fair return upon the properties.

Responsibilities of the Railway Commissioner

It is the duty of the railway commissioner to keep informed on the affairs of the German railway company and to "approve or disapprove" any steps that are taken. In case of failure to meet charges or of threatened default the commissioner is empowered to take over the management of the entire system and to "issue positive orders, whether for stopping expenditures or for a reasonable increase in existing tariffs."

When the experts made their investigation, the debt of the railways had been virtually wiped out by the depreciation of the mark. The plan of the experts in effect laid a new mortgage upon them of $2,620,000,000, represented by the reparation bonds now held in trust for the Allies.

Officers in Charge of Railways

Responsibility for management is vested in an Administrative Board or board of directors composed of 18 members. Their terms are six years. All of the directors are required to be either business men of experience or professional railway men. Members of the German Parliament or of the State legislatures and officials of the central or State governments are not eligible for membership in the Board.

General Provisions

It is provided that the concession under which the railways are held by the German railway company shall last until the reparation obligations have all be retired, which is expected to take place within 40 years or less. The properties are then to be returned to the German Government free of all debts and burdens.

In the meantime the corporation is to have a monopoly of railway operations and extensions in Germany. The German Government has a certain degree of control over the corporation, but not such as to prevent it from earning profits sufficient to cover interest, dividend and sinking-fund charges.

Expected Earnings in Excess of Needs

That the earning power of the new railway company is well in excess of interest requirements on its bonds appears from an examination of the properties and estimated earnings. Gross revenues are estimated at approximately $1,000,000,000 annually, with a net income after the period of transition amounting to $200,000,000 after providing for reserves.

The estimate of earnings for the six months ending March 31, 1925, is as follows:

Gross earnings ....$ 548,000,000

Operating Expenses	443,000,000
Net Earnings	105,000,000
Interest on First Mortgage:	
Reparation Bonds	24,000,000
Balance	81,000,000
Reserve Funds	18,000,000
Balance after service of First Mortgage Bonds and Reserve Funds	63,000,000

The company is relieved from the obligation to carry mails and post parcels gratis and is paid for this service at commercial rates. Hitherto the railways have paid hardly any taxes—federal, state or local—and this exemption is continued under the present organization.

The assurance that under the new regime railway rates will not be lowered to favor certain industries but will be maintained at levels such as to give a fair return to the railways, together with a reasonable expectation of the customary transit traffic in Germany and the inability of canal systems to afford great relief, are counted upon to enable the railways to earn their estimated income.

Comparison with Pre-War Records

Prior to the war, the income of the German railways, before deducting interest and sinking funds payments, was as follows:

Year	Amount
1910	$219,000,000
1911	251,000,000
1912	252,000,000
1913	238,000,000

Actual traffic on the railway lines before and since the war shows the following notable increases:

(000,000's omitted)

Fiscal Year	Passenger Miles	Freight Ton-Miles
1913-1914	21,800	35,500
1921-1922	30,500	39,200
1922-1923	45,900	42,500

For the first five years of operation by the new company, net earnings available for interest and sinking fund payments, after provision for adequate reserves, were estimated by the Committee of Experts, as follows:

1st Year	$95,000,000
2nd Year	131,000,000
3rd and 4th Years, 167,000,000 to	179,000,000
5th and Subsequent Years	190,000,000

The annual payments to be made for interest and sinking fund on the First Mortgage Reparation Bonds are $48,000,000 for the first year beginning September, 1924, and ending August 31, 1925, increasing to $157,000,000 for the fourth year and thereafter.

According to the latest information, the above estimates of earnings will be exceeded and it is now estimated that for the fifteen months beginning October 1, 1924, and ending December 31, 1925, the net earnings available for debt service and reserves will be about $250,000,000.

Transport Tax to Pay Reparations

Apart from the net earnings or profits as calculated in the foregoing paragraphs, the experts decided that the users of the railways would be able to pay a transportation tax, the proceeds of which would be applied to reparation payments. At the time of the experts' report this tax was already being levied by the German Government and was handed over by the railways directly to the Ministry of Finance. It therefore forms no part of the actual earnings of the railways. The transport tax, averaging 6 per cent of gross receipts from railway traffic, will produce about $50,000,000 annually. In order to give an idea of the amounts to be derived from the railways, this sum should be added to the net earnings, thus resulting eventually in a total of $250,000,000 yearly.

The transport tax does not exceed in amount the taxation levied on railways in other countries. Exclusive of the tax the German railways are required under the plan for reparation payments to earn only a fraction over 3 per cent on their capital.

"This can hardly be regarded as an excessive rate of interest. If the German railways are required to pay very little more than 3 per cent for reparations they ought, under efficient and economical management, to earn a substantial surplus over and above, which can be applied in relief of the general taxation of the country," states the experts' report.

Safeguard for Investors

The law creating the new railway company, passed by the German Reichstag, cannot be changed without Allied consent. By the provisions of the act the railway company shall be free from governmental interference except to prevent tariff discriminations. Control by the German Government "shall never be exercised so as to impair the ability of the railroad company to earn a fair and reasonable return on its capital value including . . . a return on its ordinary shares (common stock) and adequate reserves for all purposes including amortization of capital," according to the ruling laid down.

Against the exercise of control by the German Government in such a way as to prevent the company from earning adequate revenues, there is provided a right of appeal to a special tribunal and a further appeal, if necessary, to an arbitrator oppointed by the president of the Permanent Court of International Justice. In case the railway directors should fail to invoke the arbitration clause for the benefit of stockholders and creditors, the railway commissioner is empowered to do so.

Railroads Using More Fuel Oil

A total of 63,206,034 barrels of fuel oil was consumed by locomotives of the principal railroads in the United States in 1924, compared with 58,005,295 barrels in 1923, according to returns received from railroads by the American Petroleum Institute. This represents an increase of about 12 per cent.

The returns to the American Petroleum Institute show that American railroads consumed relatively more domestic fuel oil in 1924 than in the previous year. The total consumption of 63,206,034 barrels in 1924 was made up of 51,251,563 barrel of dmesic fuel oil and 11,954,471 barrels of Mexican fuel oil. In 1923 domestic fuel oil consumed amounted to 46,407,231 barrels and 11,598,064 barrels of Mexican fuel oil.

The largest consumption of fuel oil was shown in the Middlewestern and Southwestern districts, totaling 32,651,547 barrels in 1924 divided into 22,274,891 barrels of domestic fuel oil and 10,376,656 barrels of Mexican fuel oil. This compares with 27,448,445 barrels in 1923, of which 17,126,042 barrels were domestic fuel oil and 10,322,403 barrels Mexican fuel oil.

In the Eastern district the consumption totaled 115,230 barrels, of which 7,273 barrels were domestic fuel oil and 107,957 barrels Mexican fuel oil. This compared with 125,456 barrels consumed in 1923, of which 8,106 barrels were domestic fuel oil and 117,350 barrels Mexican fuel oil.

Shop Kinks

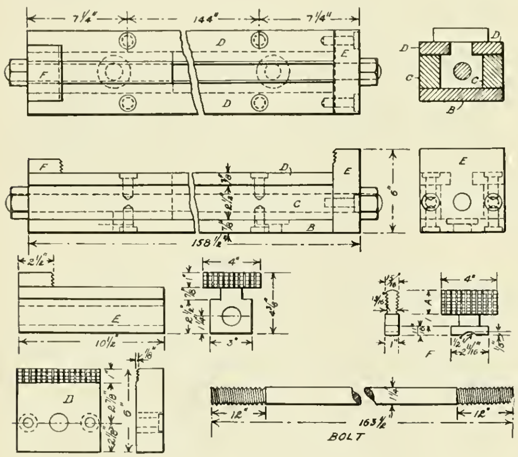
Some of the Handy Shop Devices in Use on the Erie Railroad

Jig for Shoe and Wedge Planer

This device is a long chuck for holding shoes and wedges for gang planing. The base or body is built up of five pieces forming a trough, similar to an inverted covered guide for locomotives. It is 13 ft. 2½ in. long over all. There is a botton piece *B* ⅞ in. thick and 6 in. wide on wheel which are set the two side pieces, *C*, measuring 1½ in. by 2½ in. and above these are the two top pieces *D* measuring ⅞ in. by 2 7/32 in. The whole structure is held together by fillister headed screws spaced 12 in. apart from center to center.

To one end of this structure the stationary dog *E* is fastened. This dog extends across the full width of the base, and its teeth rise 1 in. above its upper surface. This with the base forms the fixed portion of the device.

At the other end the clamping dog *F* is inserted. This has a bearing face 10½ in. long that extends into the space formed by the parts *B, C* and *D,* and its length prevents it from tilting when it is drawn against the work. A bolt 1¼ in. in diameter is passed through the holes in the two dogs and by means of the nuts at the ends the two are drawn towards each other.



Jig for Shoe and Wedge Planer

When setting up, a spacing dog *F* is placed between each two shoes or wedges so that each piece is caught and held at each end.

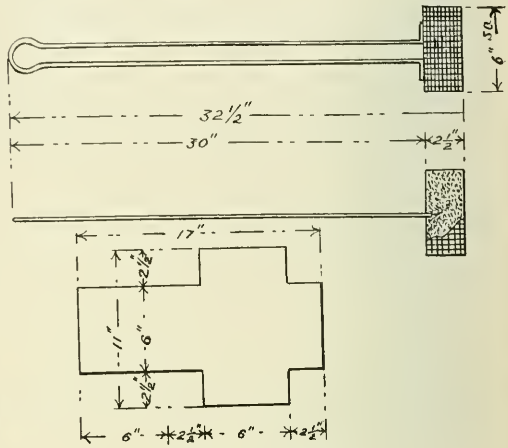
These dogs, like the movable end dog, have jaws 4 in. wide, but unlike the other two their jaws are made to rise to different heights above the top of the base according to the character and thickness of the work that they are to hold. They are made in four sizes for the dimension *A,* namely 1 in., 1½ in., and 2½ in.

In setting up the work is laid on top of the base and one of these spacing dogs is dropped down between each two adjacent pieces. The 1¼ in. bolt is then passed through the set and, by tightening one of the end nuts, the whole is clamped firmly together.

When the work is done a loosening of an end nut makes everything free and it is unnecessary to remove the tightening bolt either to take off the finished pieces or to put on fresh one.

Oil Burner

It is frequently desirable to apply a moderate amount of heat to or get a light in inaccessible places. This oil burning torch is designed to accomplish such a purpose.



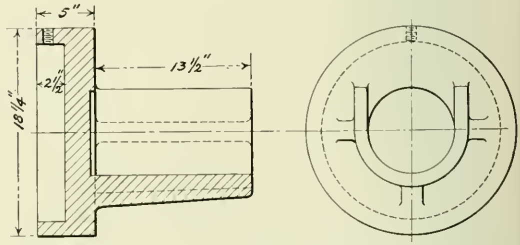
Details of Oil Burner

A ⅜ in. mesh wire netting is cut to the shape shown in the detail, and the wings are then bent up and over to form the rectangular box shown in the assembly drawing. This is filled with asbestos and attached to the 30 in. handle made of ⅜ in. round iron as shown.

When the asbestos is saturated with oil, it forms an indestructible torch that can be used for the purposes indicated.

Sleeve for Pulling Crank Pins from Wheel Centers

This is a device to be used on a hydraulic press by means of which a crankpin can be pulled out of a driving wheel or, perhaps, it would be better expressed by saying, a driving wheel pressed off from a crankpin. In order to use it, the tailpiece of the press is placed between the



Sleeve for Pulling Crank Pins from Wheel Centers

wheels and a heavy pin set against it with a bearing on the crankpin.

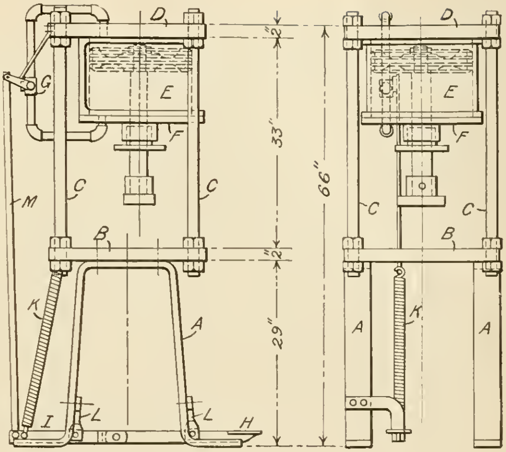
The sleeve that has been attached to the plunger of the press straddles the crankpin and has a bearing against the crank hub of the wheel. The outward movement of the plunger forces the wheel towards the tailpiece, which with the improved bar prevents the crankpin from moving and so forces it out of the wheel.

Forging Press

This press is operated by compressed air and is used for light operations. It consists of an inverted 16 in. cylinder, carried by a pair of legs and held between two tables. Air is admitted to and exhausted from the cylinder by a three-way cock.

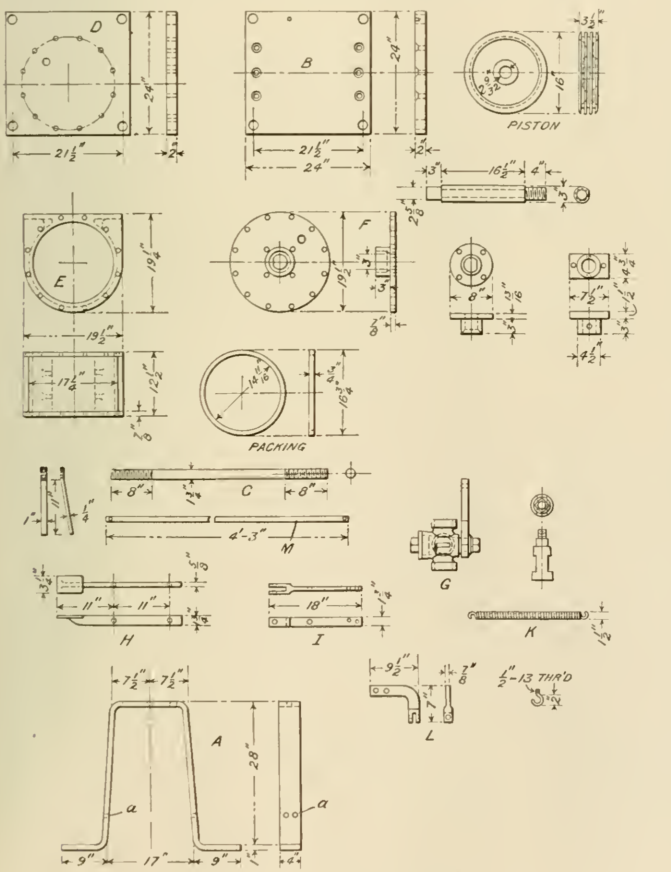
The legs *A* are of the shape shown and are made of 1 in. by 4 in. flat steel. They stand 29 in. high above the floor. These legs carry a plate *B* that is 24 in. square and 2 in. thick, which forms the base of the machine. It is bolted to each of the legs by three ⅞ in. countersunk bolts.

Four uprights *C* each 1¾ in. in diameter rise from the corners and are held by a nut on each side of the plate, *B* and serve to support an upper and similar plate *D* to the lower side of which the cylinder *E* is bolted, and for which it forms the upper head.



Air Operated Forging Press

This cylinder is 16 in. in diameter and its piston has a stroke of 6 in. Its lower head *F* is of the ordinary form with a stuffing box cast on. The piston rod is 3 in. in diameter, threaded at the piston end, into which it is screwed, being also held by a check nut in addition. The head attached to the lower end of the rod slips over a portion 2⅝ in. in diameter and has a bearing against a shoulder. It is held in place by two ¾ in. set screws.



Details of Air Operated Forging Press

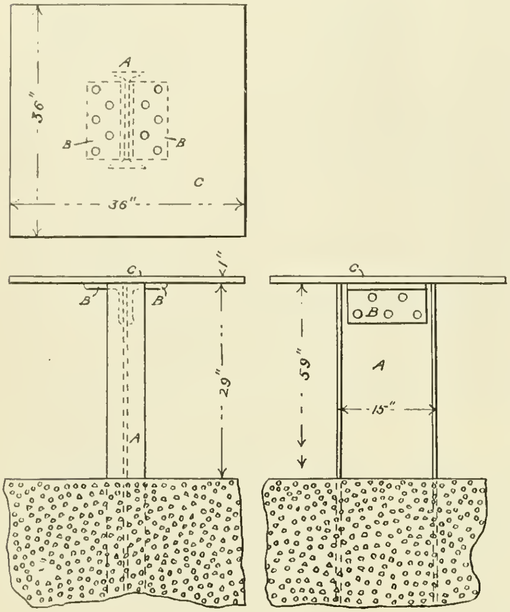
The piston is packed with three split rings, each ¾ in. wide and turned to a free diameter of 16¾ in.

Air is admitted to a three-way cock *G* which is operated by a pair of levers *H* and *I*. These levers are pivotted on the fulcrums *L* which are bolted to the left hand leg by ⅝ in. bolts passing through the holes *a*.

The lever *H* has a foot rest by which the operator moves it. A downward pressure of the foot raises it at the other end, where it is connected to the lever *I*. As this lever is pivotted near its center, its outer end is depressed, pulling down the bar *M* and turning the three-way valve so as to admit air to the upper end of the cylinder. When the pressure at the outer end of the lever *H* is relieved the spring *K*, which is of ⅜ in. steel wire and is working in tension, raises the outer end of the lever *I*, thus shutting off the flow of air to the top of the cylinder, and exhausting it instead, while the pressure is admitted to the lower end, and pushing the piston to the upper end of its stroke. As the movement at the outer end of the lever *H* in order to operate the valve is very slight, a rapid movement of the piston up and down is easily obtained.

A Round House Work Bench

A very simple and substantial work bench for the roundhouse is in use in Meadville. It is made of four pieces of metal riveted together. There is the leg *A* which is made of a 15 in. I beam 59 in. long of which 30 in. is buried in a concrete foundation leaving 29 in. projecting above to carry the table piece *C*. This latter is 1 in. thick and 36 in. square and is riveted to the I beam by means



Round House Work Bench

of 2 pieces of 6 in. by 6 in. by ⅝ in., angles *B*, weighing 24.2 lbs. per foot.

The angles are riveted to the plate by five ¾ in. rivets, in each, which are countersunk at the top in the plate. Five ordinary ¾ in. rivets are also used for fastening the angles, which are cut to a length of 12 in., to the I beam.

B. of L. E. Opposes Automatic Train Control

In connection with the application of the Delaware & Hudson Co., for an interlocutory injunction restraining the Interstate Commerce Commission from attempting to enforce the orders directing the railway to install automatic train control, Warren S. Stone, grand chief of the Brotherhood of Locomotive Engineers, stated in an affidavit that the members of the brotherhood were opposed to automatic train control. He said in part:

"No automatic device that has yet been manufactured is able to think; intelligent judgment and discretion, illuminated by experience and thoughtfully exercised, are at all times necessary for the proper control of trains and brakes.

"The chances of automatic train stop or train control being made necessary by the engineer becoming paralyzed or dying, or for any other reason being unable to exercise his functions, are about one in 10,000,000, while automatic train stop or train control, in the present state of the development of the art, will probably fail once in every 2,000 or 3,000 operations.

"The right kind of automatic train-stop or train-control apparatus has not yet been put on the market."

Snap Shots

By THE WANDERER

When the bull sees the red rag, he is apparently ready for the charge, regardless of the number of times that it is flaunted before him. In that respect I acknowledge the likeness to the bull, and am ready for a charge whenever I come into contact with the pocket handkerchief racks above the windows in the ordinary day coach.

So here I am again pounding away at the same old hobby and all because I happened into a well-filled day coach at about half past three the other morning. It was a big coach seating eighty-eight passengers. There were a score or so of passengers scattered about in every conceivable attitude of uncomfortableness.

The car was brilliantly, even extravagantly lighted, and, with its red plush seats and light colored head linings, it held an air of cheerfulness personified. It was warm withal and gave one coming in from the cold outside, a feeling of hospitality. But my red rag was there, in the form of a row of neat little black baskets arranged above the windows, some containing hats, while bundles and heavy valises were stored in the aisle and between the seats in great profusion and to the great discomfiture of the passengers. Again I ask, why wouldn't it have been better and more economical to have put in the long, broad New Haven rack and added amazingly to the comfort of all?

But this was not all. The car was warm and fresh when I entered, but I, with a score or more others, filled the car, for everyone wanted a separate seat, and I presume the air soon became foul. At any rate the conductor appeared shortly with his ventilator stick and proceeded to open some of the ventilators in the deck.

They were of that abominable drop pivot sash type, for which I trust the good Lord will forgive himself for having permitted some human to invent. At any rate there they were, and straightway the car became cold and draughty. Women and men began to put their wraps about them and there was added an air of chill discomfort. If only the conductor had known enough to open those ventilators on the lee side of the car it would not have been so bad. But no, he must open them to windward and the passengers stood for the consequences.

Now car ventilation is no joke, but the exhaust ventilator has proven itself to be the best. The ingress of air is easily accomplished. Every crack and crevice about a door or window is a ventilating shaft that serves as an intake, and a good exhauster will keep the air of a car fresh and pure. And why a car should be built with ventilators that simply allow cold air to blow in at the top and down on the heads of the passengers, and so fitted at the same time, that the movements of their feet are hampered by innumerable valises that should be stowed over head, passes my comprehension. Probably it was a case either of didn't think or failed to observe.

I must say, however, that in spite of the down-pour of cold air on my head, the conductor and trainmen did close the doors after them as they came in and went out, and they were kept closed during station stops. This may have been a habit cultivated by the intense cold that predominates in this northern country during the winter. But whether it is or no, it was a pleasant change from the left open door practice of which I have had occasion to complain in previous lucubrations. But it does seem that the pocket handkerchief rack and the drop sash ventilators are crimes against good design that are unpardonable.

I had a stop watch in my pocket the other day, and it will be long before I cease regretting that I had no inkling of what I was to be privileged to see, so that I could have used it to get some records of value.

The late Frederic Taylor used the stop watch with heartless emphasis and forced a pace that may or not have been for the best. But here was a case of just simple ordinary or extraordinary efficiency on the part of a Pullman porter that would have made a worth while record.

I haven't the remotest idea of the course of training to which a would-be porter is subjected before he is placed in charge of a car, but the stop watch record of performance cannot be a part of it, else some of them would not be as unconscionably slow as they are.

But this case which I didn't time seemed remarkable. Three or four minutes to prepare a berth was probably his limit, and then in the morning where the arrival at destination was early, this porter, instead of wasting his energies and the passengers' patience in brushing you off, had the berths made up almost before the occupant had reached the toilet room. And he so kept up with the work that everyone had a comfortable place to sit in at the completion of the toilet. And, incidentally, he had plenty of time to "brush you off" and gather in his tips. Yes, I am very sorry I did not use a stop watch on him, and be able to offer a suggestion to the company as to what they should aim to accomplish in the training of their men. But, perhaps, the fellow may attract attention to his work, and be used as an example to, or a goal to be reached in the training of others.

This brushing you off is a good deal of a farce in these days. First because there isn't much dust to be brushed off and second because the porter makes not the slightest effort to brush off what there is. His movements with the brush always remind me of those quick withdrawing taps that the personifying sissy of a vaudeville team delivers to his partner when he becomes "real mad at him." You can feel that the brush is touching you, but with the exertion put into its manipulation you know that its dust-removing capabilities are nil.

Well! That is all right now-a-days, for with the closely fitting windows, almost smokeless combustion on the locomotive and stone ballast on the roadway, the sources and conduits of dust are about destroyed. In fact this generation has no conception of the dust-producing capabilities of the old railroad. They have never seen the shower of sparks that came from the conical stack of the old wood burners which produced the real thing, and in undreamed of quantities. An open window was pretty sure to mean a burn or a scorch, and a hot cinder in the eye was no joke. Of course, numerous fires were started by this red hot shower, but as it was in dry grass for the most part it did not excite much comment. And dust! Well, stone ballast was unknown and clean gravel was rare, so that a train swept by in a cloud of dust that shut it out of view in a hundred feet. The linen duster was the traveling costume en regal, and dusters they were. But—turned close up under the chin and down to the ankles they effectively protected the clothes beneath. Then add one handkerchief tucked about the neck, another tied over the hat and a pair of gloves, and semi-cleanliness became a possibility, except for the face, which a day's journey was sure to begrim.

But with the advent of the improved front ends and stone ballast, the duster has disappeared as an article of traveling apparel because there is now but little if any more dust in a railroad car than in the rooms of an apartment that open upon a busy city street.

So with old times, old customs pass, and in the place of the linen duster we have the colored one, with no real need of either.

A Pullman conductor gave me a bit of unsolicited advice the other day that made me think that in spite of years of experience I must be, after all, a rather unsophisticated greeny. As he marked my coupon and handed it back, he said: "If anyone invites you in to a card game you had better not accept."

I believe that once, many years ago, I did receive such an invitation, which was declined and almost forgotten. As it did not seem possible in this day of gleaming light that has been thrown on the ways of the card sharps, that anyone traveling on a Pullman car could get caught, I asked him about it. And to my amazement found it to be a rather common practice.

And the people who get caught! They are not of the rabble, but business men of supposed common sense. For example he told me of the president of a western railroad who was the occupant of a drawing room in which he entertained three of the gentry who drank his whiskey, smoked his cigars and bade him good day with between three and four hundred dollars of his money in their pockets. Needless to say he got small sympathy from the conductor whom he told of his loss.

To me it was a case of live and learn. I have often wondered why sleeping passengers are not more frequently robbed at night, after the conductor and porter have both gone to sleep, and it speaks well for their general vigilance that passengers are so immune. But, of course, they cannot protect the natural born sucker from going into a little game if he sees fit. But the, to me, strange point is that there should be the suckers to get caught. Here, then, is a danger in Pullman travel of which few people have an idea, but against which a little common sense would afford an absolute protection.

It is among the rules of marine service that the crews of all vessels should be subjected to a fire and boat drill, and in case of an accident, one of the points first looked into is as to whether these rules have been observed and the crew properly drilled. On pilot and fishing boats such a drill is probably not enforced because of the constant practice to which men engaged in such service are subjected.

The railroads have never had a drill, because in the old days of hand brakes and link and pin couplers there was a brakeman for every two cars on passenger trains, and his services were required for every stop, and his ears were attuned to catch that blast of the whistle which called for brakes.

With the introduction of the air brake the brakeman became a trainman, and two such men were sufficient for a train. His activities changed and he may serve a lifetime without ever putting his hand to a brakewheel. He is shut up in a comfortable car and the engineer handles the brakes. But, occasionally the brakes fail and there is a collision or derailment with a resultant loss of life and personal injury. And this partly because the train crew did not respond to a call for brakes even if it were made when the emergency arose.

Now why would it not be well to have an occasional surprise brake drill. It could not be expected that as quick a stop would be made as with an emergency application of the air brakes, but if every Pullman porter and conductor, with the two trainmen, conductor, baggageman, and fireman were trained to jump to the hand brakes on a call, the speed could probably be so reduced as to materially modify the effect of an impact. Certainly such a training for an emergency would do no harm and might do much good.

We had that training once, but disuse has caused our faculty of quick response to atrophy.

Mechanical Division Meeting of the A. R. A.

A strictly business meeting of the Mechanical Division, American Railway Association, will be held at the Drake Hotel, Chicago, Illinois, June 16 to 18, inclusive, 1925.

This meeting is confined to members authorized to represent and vote for the railroads, and members of committees, although there is no objection to any railroad sending such representative members as they may desire.

The business before this meeting will be the consideration of and acting upon reports of the various committees of the Division; and, in addition, two or three individual papers on important subjects will be presented and discussed.

The meeting will be called to order promptly at 10:00 A. M., Tuesday, June 16th. The sessions will continue all day, each day, opening at 9:30 A. M. on Wednesday and Thursday, the 17th and 18th.

All voting representative members of the railroads are urged to be present, in order that proper consideration may be given to all committee reports and subjects coming before the Division and proper action taken.

Advance copies of reports of committees will be sent to the members as long in advance of the meeting as possible.

Notes on Domestic Railroads

Locomotives

The Central of Georgia Railway has placed an order for 5 Mountain type locomotives with the American Locomotive Company.

The Winston-Salem Southbound Railroad has ordered 2 Mikado type locomotives from the Baldwin Locomotive Works.

The Rutland Railroad has placed an order for 3 Pacific type locomotives with the American Locomotive Company.

The Reading Company is inquiring for 5 switching type locomotives.

The Atlantic Coast Line Railway has placed orders for 15 Santa Fe type locomotives, and 10 Pacific type locomotives, with the Baldwin Locomotive Works.

The Indiana Harbor Belt Railroad has placed an order for 5, 8-wheel switchers, to be equipped with feedwater heaters and 10,000 gallon tenders with the Lima Locomotive Works.

The McCloud River Railroad has placed an order for 2 locomotives with the American Locomotive Company.

The Chicago, Rock Island & Pacific Railway has placed orders for 10 Santa Fe type locomotives with the American Locomotive Company.

The Sloss-Sheffield Steel & Iron Co. has placed an order for 3 Mikado type locomotives with the American Locomotive Company.

The Chicago, Burlington & Quincy Railroad has placed orders for 13 Mountain type locomotives with the Baldwin Locomotive Works.

The Midland Valley Railroad has placed an order for 5 Mikado type locomotives with the Baldwin Locomotive Works.

The Florida East Coast Railway is inquiring for 15 light Mikado type locomotives, also for 6, 8-wheel switchers.

The Atlantic Coast Line Railway is reported to be inquiring for 25 locomotives.

The St. Louis-San Francisco Railway has placed an order for 15 Mikado type locomotives and for 5 Mountain type locomotives with the Baldwin Locomotive Works.

The Lehigh & Hudson River Railroad has ordered 4 Consolidation type locomotives from the Baldwin Locomotive Works.

The Kansas City, Mexico & Orient Railway is inquiring for 4 Mikado type locomotives.

The Pittsburgh & Lake Erie Railroad has placed orders for 10 locomotive tenders with the Lima Locomotive Works.

The Salvador Railway has placed an order for one Consolidation type locomotive with the Baldwin Locomotive Works.

The Nevada Copper Belt Railroad has ordered one locomotive from the American Locomotive Company.

The Wichita Falls & Southern Railroad has ordered 2 Consolidation type locomotives from the Baldwin Locomotive Works.

The Detroit & Toledo Shore Line Railroad is inquiring for 3 switching type locomotives.

The Jacksonville Terminal Company is inquiring for 4 switching type locomotives.

The Detroit Terminal has ordered 2, 8-wheel switching type locomotives from the American Locomotive Company.

The Southern Pacific Company has authorized the construction in its Pacific System shops of 18 Mountain type locomotives.

The Fairport, Painesville & Eastern Railroad has ordered one switching type locomotive from the American Locomotive Company.

Passenger Cars

The Northern Pacific Railway has placed an order for 10 observation cars with the Pullman Car & Mfg. Company.

The Pullman Co. has placed an order for 200 sleeping cars with the Pullman Car & Mfg. Company.

The New York, Chicago & St. Louis Railway has placed an order for 2 baggage cars with the American Car & Foundry Co.

The Southern Pacific Co. is inquiring for 10, 72-ft. coaches, 5, 70-ft. steel baggage cars, 6, 70-ft. baggage postal cars, and 6, 70-ft. baggage horse cars.

The Florida East Coast Railway has placed an order for 2 dining cars with the Pullman Car & Mfg. Co.

The New York Central Railroad has placed an order for 22 dining cars with the Pullman Car & Mfg. Co.

The Richmond, Fredericksburg & Potomac Railroad is inquiring for 6 coaches.

The Chicago, Rock Island & Pacific Railway has ordered 5 baggage-mail cars from the Standard Steel Car Co.

The Central Vermont Railway has placed orders for 40 steel underframes for refrigerator milk cars with the American Car & Foundy Company.

The Erie Railroad is inquiring for 32 passenger car underframes.

The Tennessee, Alabama & Georgia Railroad has placed an order with the J. G. Brill Company for one combination passenger-baggage motor car.

The New York Central Railroad is inquiring for 50 baggage cars, 20 coaches, 10 dining cars, and 10 suburban coaches.

The Pennsylvania Railroad has placed an order for one combination passenger baggage motor car with the J. G. Brill Company.

The Central Vermont Railway has placed an order for 20 steel underframes for refrigerator milk cars with the American Car & Foundry Company.

The Florida East Coast Railway is inquiring for 15 passenger coaches; also 15 baggage cars.

The New York Central Railroad has placed orders for cars for passenger train service as follows:—American Car & Foundry Company, 25; Standard Steel Car Company, 15; Pressed Steel Car Company, 10.

The Nashville, Chattanooga & St. Louis Railway has ordered 2 steel baggage cars from the American Car & Foundry Company.

Freight Cars

The Central Vermont Railway has placed orders for 70 steel underframes for flat cars with the American Car & Foundry Company.

The General Refrigerator Line is reported to be about to issue inquiries covering repairs to 350 refrigerator cars.

The Atlantic Coast Line Railway is inquiring for 200 phosphate cars and 500 40-ton box cars.

The Chicago Rock Island & Pacific Railway is inquiring for 100 gondola car bodies.

The Cities Service Company has placed orders for 783 steel tank cars with the American Car & Foundry Company.

The New York Central Railroad is inquiring for 500 refrigerator cars, and 500, 70 ton coal car bodies.

The Union Refrigerator Transit Co. has placed orders for 2 steel underframe refrigerator cars.

The Rettlier Coal Co. has placed orders with the American Car & Foundry Company for 25 mine cars.

The Western Fruit Express Co. has placed orders for 225 steel underframes for refrigerator cars with the American Car & Foundry Company.

The Pennsylvania Salt Mfg. Co. has placed an order for 10, 50-ton tank cars with the American Car & Foundry Company.

The Sloss Sheffield Steel & Iron Co. has placed orders for 75 hopper cars and 35 gondola cars with the Tennessee Coal Iron Railroad.

The Charleston & Western Carolina Railway has placed orders with the Tennessee Coal Iron Railroad for 100 box cars.

The Chicago Burlington & Quincy Railroad has placed orders for 500 mill-end gondola cars with the Western Steel Car & Foundry Company.

The Union Railroad is inquiring for 20 caboose cars and 12, 70-ton gondola cars.

The National Plate Glass Co. has placed orders for 55, 75-ton hopper cars with the Bettendorf Co.

The Baltimore & Ohio Railroad is inquiring for 200 underframes for freight cars.

The Industrial Coal Co. has placed an order for 50 pit cars with the American Car & Foundry Company.

The New York Central Railroad is inquiring for 300 flat car bodies.

The Vacuum Oil Co. has placed an order for 4 steel hopper cars with the American Car & Foundry Company.

The Quaker City Tank Line has placed orders for 100, 40-ton refrigerator cars and 250, 30-ton stock cars with the General American Car Company.

The Central Vermont Railway has placed an order for 12 steel underframes for caboose cars with the American Car & Foundry Company.

The Verde Tunnel & Smelter Railroad of Arizona has placed an order for 15, 75-ton ore cars with the Pressed Steel Car Co.

The Chicago Indianapolis & Louisville Railroad has placed orders for 500 box cars and 250 gondola cars with the Pullman Car & Mfg. Co.

The Chicago Burlington & Quincy Railroad has placed an order for 16 tie trams with the American Car & Foundry Compnay.

The Swift & Co. has placed orders for 300 refrigerator cars with the Illinois Car & Mfg. Company.

The Oneida & Western Railroad is in the market for a number of caboose cars.

The Peidmont & Northern Railway has ordered 150 automobile cars from the Pressed Steel Car Company.

The Missouri Kansas Texas Railway is inquiring for 500 steel underframes, 40-ton refrigerator cars; 1,000 steel underframes, single sheath, 50-ton box cars; 300 drop bottom, 50-ton gondola cars.

The Southern Pacific Company has issued an inquiry for 2,000 box cars, 1,000 gondola cars, 200 automobile cars, and 200 tank cars.

The Baltimore & Ohio Railroad has ordered 750 car ends from the American Car & Foundry Company.

The Maine Central Railroad has placed an order for 2 box cars with the Standard Steel Car Co.

The Delaware, Lackawanna & Western Railroad is inquiring for 300 steel underframe refrigerator cars.

The Tidal Oil Co., Tulsa, Okla., has issued inquiries covering 60 tank cars.

The New York Central Railroad is inquiring for 100 dump cars.

The Ulster Foundry Corporation has placed an order with the American Car & Foundry Company for 2 steel underframe transfer cars.

The New York Central Railroad has placed an order for 500 gondola cars for the Cleveland-Cincinnati-Chicago & St. Louis Railway with the American Car & Foundry Company.

The Boston & Maine Railroad is inquiring for 500 box cars.

The Grand Trunk Western Railway has placed an order with the Pressed Steel Car Company for 25 caboose underframes.

The Carnegie Steel Co. has placed an order for 12, 70-ton gondola cars with the Standard Steel Car Co.

The Dow Chemical Co. has placed an order for one tank car with the American Car & Foundry Company.

The Barrett Company has placed orders covering repairs to 141 tank cars with the American Car & Foundry Company.

Building and Structures

The Central of Georgia Railway has authorized the construction of a new roundhouse at Savannah, Ga., to cost approximately $150,000.

The Illinois Central Railroad plans the construction of extensive shops at Belle Rive, Ill., on the new line between Edgewood, Ill., and Paducah, Ky., which will include machine and car repair shop, engine house, office buildings and storage tracks.

The Wichita Falls & Southern Railroad will commence work at once rebuilding its shops and roundhouse at Wichita Falls, Texas, which were recently destroyed by fire at a loss of about $125,000.

The Erie Railroad is preparing plans covering an addition to its engine house at Meadville, Pa.

The Pennsylvania Railroad plans the construction of an addition to its engine house at Enola, Pa., with repair facilities.

The Pittsburgh & Lake Erie Railroad is inquiring for bids covering the construction of a new engine house at McKees Rocks, Pa.

The Long Island Railroad has awarded a general contract covering the rebuilding of its shop at Morris Park, New York, which was recently destroyed by fire.

The Gulf, Colorado & Santa Fe Railway plans the construction of a one-story machine shop at Cleburne, Texas.

The Mt. Pleasant Railroad plans the construction of the roundhouse at Paris, Texas, which was recently destroyed by fire, at an estimated cost of $150,000.

The Pennsylvania Railroad plans the construction of a six-story station and office building in Altoona, Pa., estimated to cost $1,800,000.

The Great Northern Railway plans the construction of a new 18-stall engine house, with repair shop, at Troy, Mont.

The Texas & Pacific Railway has awarded a contract covering the grading in connection with the construction of a new train yard and engine terminal at Shreveport, La., but the bids will not be taken on the new engine house and other buildings for some months.

The Illinois Central Railroad has placed a contract covering the construction of foundations for the new shops at Paducah, Ky.

The Virginian Railway plans improvements to its station at Princeton, W. Va., to include the erection of butterfly train sheds.

The Chesapeake & Ohio Railway announces the authorization of the following improvements: new engine terminal at Russell, Ky., to cost approximately $1,108,450, consisting of a 14-stall engine house, 115-ft. turntable, cinder conveyors, engine washing platform, power house, storeroom and necessary grading and tracks.

The Missouri-Kansas-Texas Railway has placed a contract with the Graver Corporation, East Chicago, Ind., covering the erection of a type "K" Graver softener of 15,000 gallons per hour capacity at Wichita Falls, Texas.

The Clinchfield Railroad plans the construction of the following buildings at Erwin, Tenn.: blacksmith shop, coach, carpenter and paint shop, freight car repair shop, also wash rooms and locker rooms. It is planned to commence building as soon as possible, and to complete the entire project this year.

The Southern Railway has placed a contract covering the construction of a reinforced concrete engine house and boiler house at Atlanta, Ga.

The Nashville, Chattanooga & St. Louis Railway has placed a contract covering the reconstruction of a reinforced concrete roundhouse at Hollow Rock Junction, Tenn., which was recently destroyed by fire. The estimated cost of rebuilding is $50,000.

The Terre Haute, Indianapolis & Eastern Railway plans the construction of its machine shop at Terre Haute, Ind., which was recently destroyed by fire.

The Reading Company is reported to be contemplating the erection of additional shop facilities at Reading, Pa.

The New York Central Railroad are having plans made to enlarge the coal dock facilities at Toledo, Ohio, which will handle 100-ton cars.

The Mobile & Ohio Railroad are having plans made for the immediate reconstruction of the shop buildings at Murphyboro, Ill., which were destroyed by the tornado.

Items of Personal Interest

O. A. Garber, formerly master mechanic of the Illinois Central Railroad with headquarters at Memphis, Tenn., has been appointed mechanical superintendent of the Missouri Pacific Railway with headquarters at St. Louis, Mo., succeeding **W. C. Smith**, who has been appointed assistant to the chief mechanical officer, with headquarters at St. Louis, Mo. Both appointments were effective March 1st.

E. C. Carey has received appointment as road foreman of engines of the Norfolk & Western Railway with headquarters at Bluefield, W. Va.

H. N. Rodenbaugh, general manager of the Florida East Coast Railway with headquarters at St. Augustine, Fla., has been elected vice-president in charge of the operating department with the same headquarters.

George G. Lynch, chief draughtsman of the Atlantic Coast Line has been appointed assistant mechanical engineer, with headquarters at Wilmington, N. C.

W. F. Perkins has received promotion from the position of assistant road foreman of engines of the Norfolk & Western Railway to that of assistant superintendent, with headquarters at Williamson, W. Va., succeeding **J. R. Derrick**, promoted.

H. Horn has been appointed assistant general manager of the Alaska Railroad with headquarters at Anchorage, Alaska.

G. G. Davis, superintendent of shops of the Cleveland, Cincinnati, Chicago & St. Louis Railway with headquarters at Beech Grove, Ind., has retired from active service.

Frank Fouse has been appointed shop superintendent of the Lehigh Valley Railroad with headquarters at Packerton, Pa., succeeding **J. E. Brong**.

John B. Starbuc has been appointed road foreman of engines of the Sacramento division of the Southern Pacific Company with headquarters at Roseville, Calif., succeeding **J. Sturm** who has been assigned to other duties.

John H. Tonge has been promoted from the position of superintendent of the Washington Terminal Company to that of general manager with headquarters at Washington, D. C.

H. C. Stevens has been appointed master mechanic of the Alamosa division of the Denver & Rio Grande Western Railroad with headquarters at Alamosa, Colo.

L. E. Cartmill has been appointed assistant general superintendent of the car department of the Pacific Fruit Express Co., with headquarters at San Francisco, Calif.

A. A. Miller has received promotion from the position of superintendent of the Memphis Division of the Missouri Pacific Railroad with headquarters at Wynne, Ark., to that of engineer of maintenance of way and structures.

J. E. Packer has been appointed assistant to the president of the Erie Railroad with headquarters at New York, N. Y.

B. V. Davis, division engineer of the Chesapeake & Ohio Railway with headquarters at Covington, Ky., has been transferred to Peru, Ind., exchanging position with **D. Hubbard.**

F. L. Sample has been appointed acting superintendent of the Detroit terminals of the Grand Trunk Railway, with headquarters at Detroit, Mich., succeeding **E. F. Gorman.**

C. L. Buckingham has been appointed as engineer of tests of the Missouri-Kansas-Texas Railroad with headquarters at Parsons, Kansas, succeeding **N. J. Broughton,** transferred.

G. H. Warning has been appointed master mechanic of the Canadian National Railways with headquarters at Regina, Sask., Canada.

W. C. Smith, formerly mechanical superintendent of the Missouri Pacific Railroad has been appointed assistant to the chief mechanical officer with headquarters at St. Louis, Mo.

H. W. Faus, special engineer on the staff of the chief engineer of motive power of the New York Central Railroad, has been appointed engineer of materials and equipment tests, with headquarters at New York City, succeeding **G. E. Doke.**

W. F. Laure, general foreman of the Illinois Central Railroad with headquarters at Memphis, Tenn., has been promoted to master mechanic to succeed **O. A. Gaber,** resigned, to accept service with Missouri Pacific Railroad.

E. L. Johnson has been appointed assistant engineer of materials and equipment tests, with the same headquarters. His former position, that of engineer of service tests having been abolished and its duties taken over by **E. C. Hardy,** general inspector.

D. S. Colby has been appointed acting assistant superintendent of the Northern Pacific Railway with headquarters at Billings, Mont., and **D. E. Nichols** has been appointed acting assistant to the general superintendent at Livingston, Mont.

Supply Trade Notes

The National Malleable & Steel Castings Company, Cleveland, Ohio, manufacturers of railroad and marine specialties and automobile castings, announce a new address for their Branch Sales Office in Chicago. After April 1st, 1925, this office will be located at 501 Railway Exchange, Chicago, Illinois, instead of 311 Railway Exchange as formerly.

Located in the center of railway activity in Chicago, this branch of the National Malleable & Steel Castings Company serves the convenience of buyers for railroads in the Chicago territory. The chief items handled are the various type of friction draft gears manufactured by the Company, including the new National Naco Steel Draft Gear, Journal Boxes, A.R.A. Standard "D" Couplers and Railway Castings.

James E. Shearer, assistant sales manager of the **Industrial Works,** Bay City, Michigan, has moved his headquarters from the home office to the Industrial Works' New York office, 50 Church street, that city. **George T. Sinks,** in charge of the New York district, will remain in that position.

Tom Moore, formerly purchasing agent of the Virginian Railway, has been appointed representative for **Gold Car Heating & Lighting Company,** in charge of the Southern territory. He is located at Room 811, Royster Building, Norfolk, Va.

Lyle Marshall, former manager of the service department of the **Industrial Works,** Bay City, Michigan, and later connected with the Chicago office of that company, has recently been appointed district sales manager with new offices at 619 Dixie Terminal building, Cincinnati, Ohio.

W. G. Willcoxsen being no longer connected with **Gold Car Heating & Lighting Company,** this company will be temporarily represented in Chicago territory by **F. O. Bailey,** manager of sales, and **A. D. Stuver;** address same as heretofore.

The Globe Steel Tube Company has opened a district sales office at 444 Frisco Building, St. Louis, Mo., and has appointed **E. C. Carroll,** manager of sales for that district.

W. Sharon Humes, sales representative of the **Magnus Company, Inc.,** with headquarters in Chicago, Ill., has resigned to become sales representative of the **Central Brake Shoe & Foundry Company,** with headquarters at Chicago, Ill.

Harry A. Flynn, who formerly served as general air brake supervisor of the Delaware & Hudson Company has been appointed mechanical representative of the **New York Air Brake Company,** with headquarters at Boston, Mass., succeeding **N. A. Campbell,** deceased.

William Bonn, formerly assistant general sales manager of the **Pullman Company,** has been appointed assistant general manager of the **W. M. Laylor Company,** railway sales representatives of the **Zapon Company.**

The Kansas City Bolt & Nut Company will construct a one-story plant in Kansas City, Mo., to cost approximately $23,000, also has opened an office in Tulsa, Okla.

The Bettendorf Company plans the construction of a three-story office building at Bettendorf, Iowa, to cost approximately $175,000.

J. C. Davis of the sales department of the **Ohio Injector Co.,** has been promoted to assistant sales manager, with headquarters at Wadsworth, Ohio.

The Kilby Car & Foundry Company, Anniston, Ala., has opened an office at 2038 Grand Central Terminal, New York, N. Y., in charge of **J. N. Brownrigg** and **Fred MacDonald.**

The Duff Manufacturing Company has moved its New York office from 50 Church Street to 250 Park Avenue.

A. S. Taylor has been appointed sales engineer for the **Central Steel Company,** Massillon, Ohio. Mr. Taylor was formerly sales engineer for the **United Alloy Steel Corporation,** Canton, Ohio.

George M. Hogan, secretary and general sales agent of the **Sellers Manufacturing Company,** has been promoted to vice-president with headquarters in Chicago, Ill.

Oscar B. Cintas has been elected vice-president and director of the **American Car & Foundry Company** succeeding **Charles S. Gawthrop,** deceased.

The American Railway Hydrant & Valve Co. has been incorporated at Stapleton, New York, with $50,000 capital by **W. Volhardt** and **M. B. N. Volkhardt.**

W. H. Ivers has rejoined the organization of the **Gold Car Heating & Lighting Co.,** Brooklyn, N. Y., as southwestern sales representative.

The Almer Tank Line Company, 464 West Jackson Boulevard, Chicago, Ill., has been incorporated to lease and deal in tank cars by **Henry Almer, E. V. Almer,** and **H. L. Bradshaw.**

The Standard Stoker Company, Inc., has removed its New York office from the Grand Central Terminal to 350 Madison Ave., New York City.

Paul T. Farrell of the purchasing department of the **Youngstown Steet & Tube Company,** Youngstown, Ohio, has been promoted to assistant purchasing agent to succeed **C. A. Ilgenfritz,** resigned.

Howard Longstreth, secretary of the **Lebanon Iron Company,** Lebanon, Pa., has been elected president, **H. W. Pratt** has been appointed secretary-treasurer, and **J. J. McDermott** has been appointed assistant treasurer.

Andrew C. Duncan has been appointed district engineer for the **Elwell-Parker Electric Company,** Cleveland, Ohio, with headquarters at 2835 Washington Boulevard, St. Louis, Mo.

The American Cable Company, has opened a district sales office at 160 N. LaSalle St., Chicago, Ill. **W. H. Slingluff** has been appointed to the sales in the mid-western states.

Allan M. Cullum has been appointed to the sales force of the **Reading Iron Company,** Reading, Pa., with headquarters at the general office of the company in Reading, Pa.

R. P. Townsend has been appointed eastern assistant manager of railroad department of **Johns-Manville, Inc.,** with headquarters at New York, N. Y. Mr. Townsend was formerly connected with the **Murphy Varnish Company.**

Joseph M. Welles has been appointed representative of the **Standard Coupler Company** with headquarters in the Peoples Gas Building, Chicago, Ill., succeeding **W. Eckels,** resigned.

The Lehon Company has moved its New York office from 95 Liberty St., to 60 Broadway, New York, N. Y.

Heyl & Patterson, Inc., construction engineers, Pittsburgh, Pa., will remove their eastern office from 90 West St., to Pershing Square Building, 100 East 42nd St., New York, N. Y. **E. Logan Hill** is eastern representative.

J. J. Flaherty has been appointed director of sales of the **Page Steel & Wire Company,** with headquarters at Bridgeport, Conn. Mr. Flaherty was formerly in charge of welding for the Boston Elevated Railways.

The Electric Storage Battery Company has bought land as a site for a factory branch to be built in Boston, Mass. It will be of modern daylight construction and will be modern in every respect.

The Ohio Locomotive Crane Company has placed **Arnold Walters,** district sales manager in charge of a newly opened district office in the Book Building, Detroit, Mich.

The Equitable Trust Co. of New York City, has been appointed transfer agent for common stock of the **Gould Coupler Co.**

The General American Tank Car Co. will move its present offices in the Harris Trust Bldg., at 111 West Monroe Street, Chicago, Ill., to larger quarters in the Illinois Merchants Bank Building.

The American Car & Foundry Company is arranging to rebuild the portion of its plant, consisting of the wheel foundry and pattern department which was destroyed by fire.

The Union Tank Car Co., Cleveland, Ohio, is taking bids covering the construction of a car repair shop at Toledo, Ohio.

Obituary

John Howard, superintendent of motive power of the New York Central Railroad, with headquarters at New York, N. Y., died suddenly on March 24. Mr. Howard entered the railway service as machinist's apprentice on the Pennsylvania Railroad at Renovo, Pa., and, in 1883 he was machinist apprentice and engine inspector for the New York West Shore & Buffalo Railway with headquarters at Kingston, New York. In 1884 he was appointed engine house foreman at Frankfort, New York, and was promoted to general foreman in 1891. In 1892 Mr. Howard was promoted to master mechanic of the River division with headquarters at New Durham, New Jersey, and, in 1901, he was promoted to superintendent of motive power and rolling stock of the Pennsylvania division of the New York Central & Hudson River Railroad with headquarters at Corning, New York, being transferred to the Western division in the same capacity in 1902, with headquarters at Depew, New York. In May, 1904, Mr. Howard was appointed superintendent at Boston, Mass., returning to the New York Central & Hudson River Railroad in November, 1904, as superintendent of motive power. When the New York Central & Hudson River Railroad was succeeded by the New York Central Railroad, Mr. Howard was appointed superintendent of motive power of that railway, in which capacity he was serving at the time of his death.

John Luther Nicholson, president of the Locomotive Firebox Co., with headquarters at Chicago, Ill., died on March 23, of pneumonia. Mr. Nicholson was born June 25, 1875, in New York City. He came to Chicago at the time the South Side Elevated Railroad started operation and assisted his father, who was master mechanic on this road at that time. In October, 1895, he entered the service of the Chicago & North Western as locomotive fireman on the Wisconsin division. He also worked as extra fireman on the Galena division. He was promoted to engineer in July, 1902, and was made assistant road foreman of engines, Wisconsin division, in 1903, remaining in this position until he left the service of the railroad in April, 1905, when he entered the service of the American Locomotive Equipment Co. to handle the sale of the hollow arch for locomotives, of which he was one of the inventors. In 1910 he entered the service of the American Arch Co., successor of the American Locomotive Equipment Co., later going into business for himself to handle locomotive appliances of which he was the inventor. In 1918 he perfected the invention known as the thermic syphon, afterwards organizing the Locomotive Firebox Co., to manufacture and sell it. Mr. Nicholson was one of the outstanding characters in the railway supply field.

Newman Erb, president of the Ann Arbor Railroad, died on March 25, following an operation at the Roosevelt Hospital, New York City. Mr. Erb was 74 years of age. He was born at Breslau, Germany, June 16, 1850. His family came to the United States in 1853 and settled in St. Louis, Mo., where he was educated in the public and private schools. He was admitted to the bar at the age of 22 and practiced law for 30 years.

His interest in railroads began actively in 1885 when he was appointed receiver for the Memphis, Selma & Brunswick Railroad, now a part of the Frisco system.

Thereafter he served in an executive capacity with several small roads and from 1886 to 1889 without relinquishing his railroad interests was president of the Western Telegraph Co., which he organized and which was absorbed by the Western Union Telegraph Co. From 1895 to 1898 Mr. Erb was vice president of the Pere Marquette. He constructed and was the first president of the St. Louis, Memphis & Southwestern Railroad, which became a part of the Frisco system.

In late years Mr. Erb has been identified primarily with the Ann Arbor Railroad which he served as president. His other interests included presidency of the Manistique & Lake Superior Railroad and the Railroad Securities Co. He was also chairman of the Middletown & Unionville Railroad, vice president of the New Dominion Copper Co., and a director of the Hall Switch & Signal Co.

Logan G. McPherson, the organizer and first director of the Bureau of Railway Economics, died on March 23 at St. Luke's Hospital, New York City, after a long illness.

He was an economist of note who devoted most of his life to questions connected with transportation. He will perhaps be best remembered by his work in connection with the organization of the Bureau of Railway Economics in 1910, of which he was the first director, retiring in 1914.

He was born in Circleville, Ohio, August 11, 1863. At the age of 16 he became a newspaper reporter in Columbus, Ohio. For the next 10 years he was connected with the Pennsylvania Lines west of Pittsburgh. During these 10 years he got well rounded experience in railroading including traffic, finance, accounting and a year in operating department with the General Manager, and from 1892 to 1901 he held various positions in the coal industry at Pittsburgh. In 1902 he went with Mr. L. F. Loree when he became President of the Baltimore & Ohio Railroad. In 1904 he was statistician of the Rock Island system and then became assistant to the late Samuel Spencer, President of the Southern Railway. He made a study of the question of railroad freight rates and as adviser to the National Waterways Commission, in 1919 he made an exhaustive analysis of rail and water transportation in Europe.

Mr. McPherson made a study of the result of the consolidation of the English railroads put into effect on January 1, 1923. He was the author of the following books: "The Workings of the Railroads," "Railroad Freight Rates," "Transportation in Europe," "How the World Makes Its Living," "Human Effort and Human Wants," and "The Money and Banking Problem."

George W. Jewett, general superintendent of the American Steel & Wire Co., in the Pittsburgh district, died of pneumonia on March 2, at his home in Pittsburgh, Pa.

Harry W. L. Porch, master car builder of Swift & Co., Chicago, Ill., and president of the Car Foreman's Association of Chicago, died on March 2, at his home in Chicago, Ill.

New Publications

Books, Bulletins, Catalogues, Etc.

Railways of Central America and West Indies.—This is the first of a series of hand books which the Department of Commerce contemplates issuing on Latin America. It shows that a progressive and steady advancement in railway construction has taken place in Central America and the Caribbean Islands during the past decade, despite economic disturbances and political disorders, is brought out in a survey of the railroads of these regions released today by the Department of Commerce.

A growth of 400 per cent in trackage, from 2,000 miles in 1914 to 10,000 miles in 1924, is disclosed by this publication.

This increase, however, it is pointed out, has been very largely due to American ingenuity and enterprise; the numerous fruit, sugar, and mining companies in these regions financed by United States capital taking the initiative in this movement. A large number of these American companies operate their own railway systems, and have a considerable amount of mileage in service. Very little has been done by individual governments themselves in extending their own systems, the report states.

The history of railway development in Central America is replete with all the thrills of fiction. From the time the first lines were laid down many of the states have been the scenes of bitter struggles between private organizations for the control of railway systems and of the industrial undertakings and natural resource developments that they serve.

Of all the countries comprehended in the report Cuba has shown the most rapid progress. Although its railroad system does not furnish direct communication between important centers, this handicap is being eliminated rapidly, and under the Tarifa Law the coordination of various lines will bring about efficient railroad connections throughout the whole island.

The International Railways of Central America have constructed one of the best railway systems in Central America. That this has been possible in spite of the divergent views of various political parties, shows a tenacity in railway development which is bound to provide a good communication system.

The volume under consideration contains 375 pages and presents complete information on ownership, operation, mileage, method of purchase, finances, traffic statistics, motive power and rolling stock. Copies can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. The price is 70 cents.

Annual Proceedings of the American Society for Testing Materials. Published by the Society at 1315 Spruce Street, Philadelphia, Pa. Issued in two volumes.

Part I (1173 pages) contains the annual reports of 35 of the standing committees of the Society, together with the discussion thereon at the annual meeting. They include reports of Committees on Ferrous and Non-Ferrous Metals, Cement, Ceramics, Concrete, Gypsum, Lime, Preservative Coatings, Petroleum Products, Road Materials, Coal and Coke, Waterproofing Materials, Electrical Insulating Materials, Shipping Containers, Rubber Products, Textile Materials, Thermometers, Methods of Testing and Nomenclature and Definitions; 87 tentative standards which have either been revised or are published for the first time; annual address of the President and the annual Report of the Executive Committee. It also contains three reports of the Joint Committee on Investigation of Phosphorus and Sulfur in Steel, Effect of Sulfur on Endurance Properties of Rivet Steel, Metallographic Investigation of Effect of Sulfur on Rivet Steel and Effect of Sulfur on Structural Steel, and the Report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete.

Part II (1133 pages) contains 47 technical papers with discussion. These include valuable information on results of investigations by experts in the field of engineering materials. This part also includes a Symposium on Effect of Temperature upon the Properties of Metals and a Symposium on Corrosion-Resistant, Heat-Resistant and Electrical-Resistance Alloys. These Symposiums include valuable new and hitherto unpublished data.

Standard Train Rule Examination, by G. E. Collingwood. Published by the author, 919 Prospect Avenue, Toledo, Ohio. This is the eleventh edition of this excellent work which is based on the Standard Code of Train Rules of the American Railway Association in effect January 1st, 1925. It is the pioneer book in explanation of the Standard Code, has attained international reputation, and has made for a more uniform understanding and systematic study of train rules and train orders.

The book is arranged for the use of examining officers, and also to enable conductors, enginemen, train dispatchers, operators, etc., to pass satisfactory examinations.

It is not claimed that any book can take the place of actual experience; however, this work is a crystallization of constructive experience and furnishes authoritative rulings which experience does not furnish.

Rulings of the American Railway Association have been followed in every case and upon points where no ruling has been made, the theory upon which the rules are based has been followed. Under each rule number, appear the examination questions and answers; an explanation of the rule followed by all rulings on such rule made by the American Railway Association.

The volume has long been a recognized authority and will be of invaluable aid not only to general officers and train dispatchers, but all those engaged in the operation or movement of trains.

Notes and Data on Railway Engineering, by Frank Reeves, late engineer in chief, Buenos Aires & Pacific Railway. Published by J. B. Lippincott Company, Philadelphia, Pa. 178 pages, 61 illustrations, and 26 tables.

Railway Engineering in new countries presents many difficulties not provided for in text-books, and although the engineer be equipped with standard works of reference, replenished from time to time with books of the latest practice, problems quite outside the range of such assistance have to be investigated. During over thirty years of extensive practice (in which his department built over 1,000 miles of new lines and took over some 2,100 miles of other ownership) the author of this work has been faced with innumerable questions which called for independent working, and the results have been carefully noted and cast into form for future reference. These have gradually grown into a useful collection of Notes and Data, including tables, formulæ, hints and wrinkles worth knowing, typedesigns which have proved successful, memoranda of trial and practice, results of experiments, etc.

Such information gathered from experience, reduced to brief expression and arranged in alphabetical sequence, is likely to be of service to engineers engaged in similar work; also to hydraulic engineers who will find herein much to interest them.

G. E. Welding Electrodes is the title of a small 16-page, illustrated booklet just issued by the General Electric Company. This booklet describes the characteristics and applications of the three types of General Electric electrode, designated as Types A, B and C. Brief instructions are given covering the use of each type.

Louisville & Nashville Employees Magazine. The first issue of this publication for the employees of the railroad appeared in March, coincident with the Diamond Jubilee of the company. It contains a message from W. L. Mapother, president of the road, historical data dealing with the growth of the railway, and articles by the principal executives dealing with the departments in their charge.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

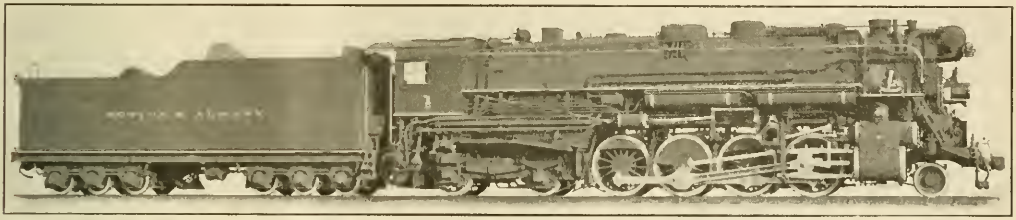
Vol. XXXVIII 136 Liberty Street, New York, May, 1925 No. 5

A 2-8-4 Locomotive for the Boston & Albany R. R.

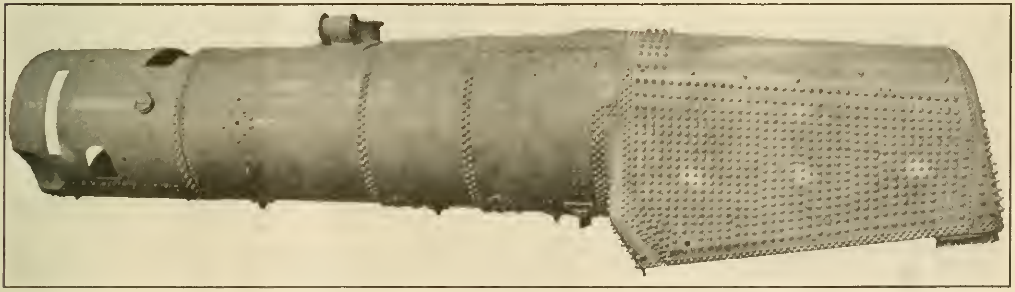
Some of the Details of the Design and Performance of a New Type of Locomotive Built by the Lima Locomotive Works

In the issue of RAILWAY AND LOCOMOTIVE ENGINEERING for August, 1922, a description was published of a Mikado (2-8-2) locomotive No. 8000 built by the Lima Locomotive Works for the Michigan Central R. R. The trial operations of that locomotive were so satisfactory that more than three hundred of them have been built and put into service on the New York Central Lines. As much of an advance as this locomotive was over its predecessors, it seems to have been quite eclipsed by this latest output which was developed as the result of careful observation of the performances in service of the No. 8000.

A comparison of the general dimensions of the two locomotives, that is of the No. 8000 (2-8-2) and the new 2-8-4, shows that the weight on the driving wheels of the latter have been increased only 200 lbs., or from 248,000 to 248,200 lbs.; the weight on the front truck has been raised from 29,000 lbs. to 35,500 lbs., while that on the trailing truck has been nearly doubled, or raised from 58,000 lbs. to 101,300 lbs., thus adding in all 50,000 lbs. to the total weight of the locomotive itself. The boiler is apparently largely responsible for this increase of weight, as it has a total evaporative surface of 5,110 sq. ft., as against 4,578 sq. ft. in the previous engine. There is also an increase of 331 sq. ft. of superheating surface, giving a total increase of 863 sq. ft. in the combined evaporative and superheater surfaces. And finally the grate area has been raised from 66.4 sq. ft. to 100 sq. ft.

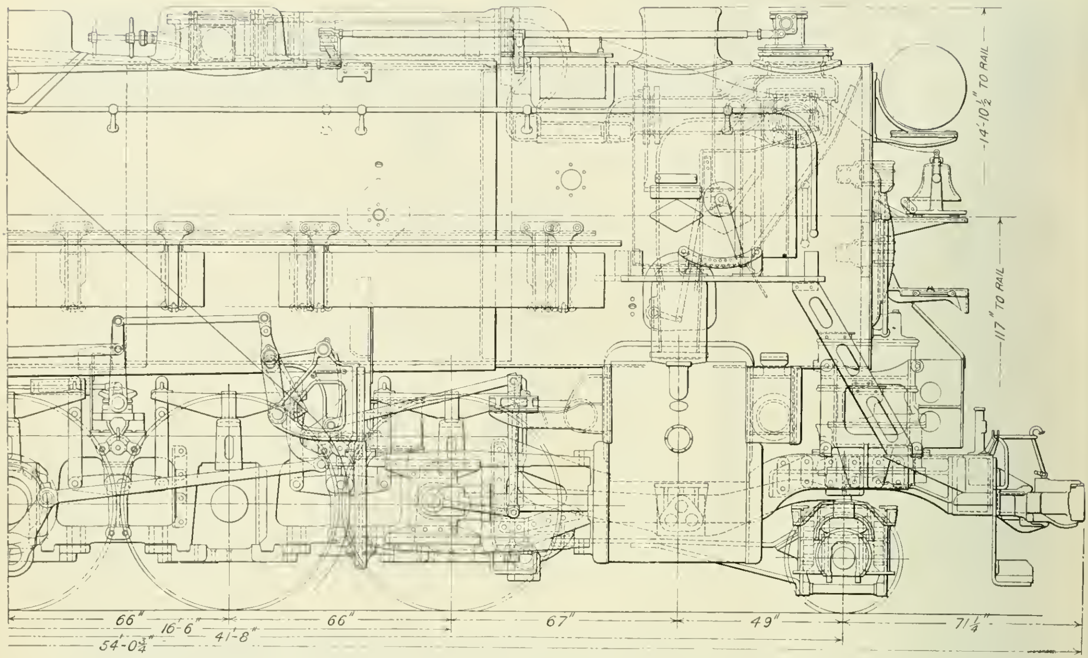


New 2-8-4 Type Freight Locomotive Designed and Built by Lima Locomotive Works, Inc.

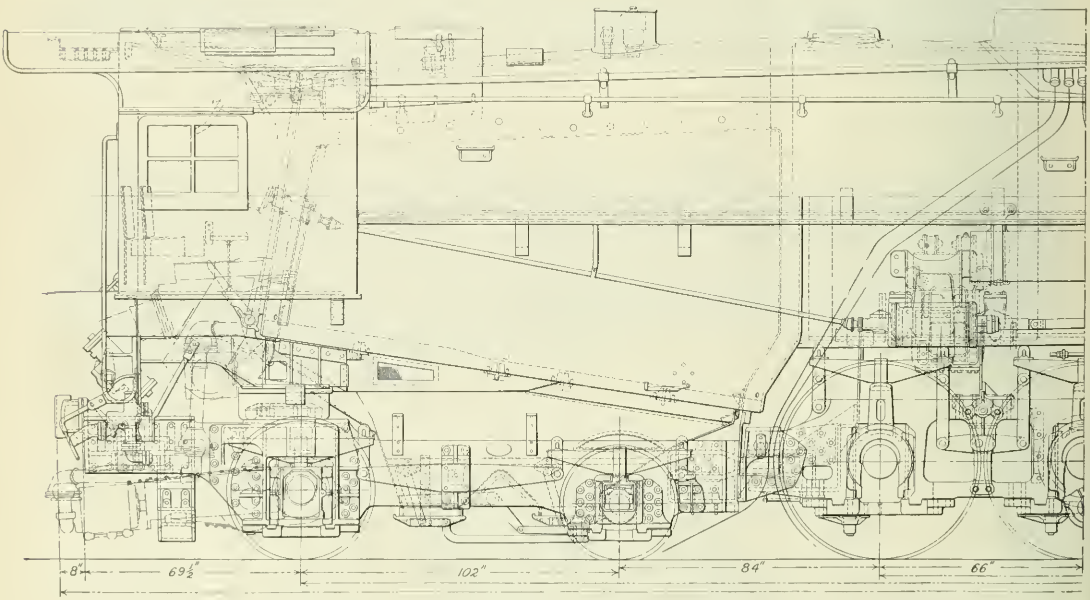


Boiler Showing Rounded Corners of Firebox and Indented Smoke Box for Air Pump and Feed Water Pumps

Putting this in the form of percentages there has been an increase of 12 per cent in the evaporative heating surface; of 18 per cent in the superheater surface; of 13½ per cent in the combination of the two, and 50 per



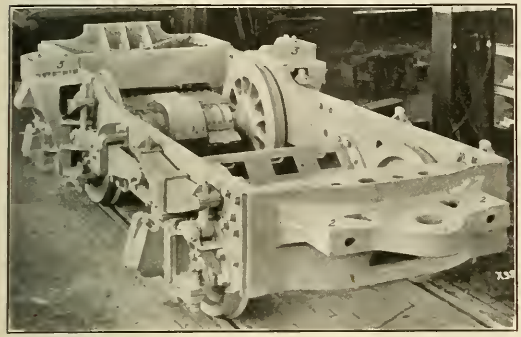
Front Half of Side Elevation of 2-8-4 Type Freight Locomotive Built by Lima Locomotive Works, Inc.



Back Half of Side Elevation of 2-8-4 Type Freight Locomotive Built by Lima Locomotive Works, Inc.

cent in the grate area, by which more economical rates of combustion are made possible.

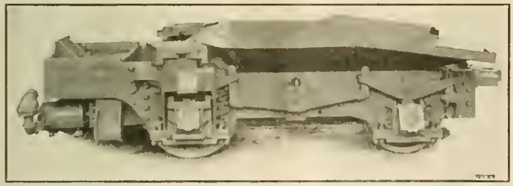
The new engine is further possessed of a number of novel features that would attract attention from even the most casual observer. First is the novel wheel arrangement by which the firebox of the boiler is carried on a four-wheeled truck that is quite independent of the main frames, and serves not only to carry the rear end of the locomotive but to transmit the tractive effort of the cylinders from the main frames back to the tender. A feature of locomotive construction that is quite new.



Trailing Truck Showing Booster Attachment and Tongue for Coupling to Main Frames

The truck performs three unusual functions in locomotive construction: it carries the back end of the boiler, independently of the main frames; it carries the ashpan independently of the boiler and the main frames and it transmits the pull of the locomotive from the rear end of the main frames to the front end of the tender. In addition to which it carries a booster engine that is coupled to its rear axle.

The main frame of the truck is built up of two steel castings, the front cross piece and the tail piece and two forged steel side pieces, the general shapes of which are clearly shown by the reproduction of the two photographs.



Trailing Truck Showing Arrangement of Ash Pan and Equalizer System

The main frames are of steel castings, as usual, and at the rear end there is a cross piece, that forms a jaw grasping the tongue 1, of the truck, through both of which a 6½ in. diameter draft pin is passed. The center of this pin is 33 in. back of the center of the rear driving axle, and 51 in. ahead of the center of the front truck axle.

Then, in addition to the grasping of the tongue of the truck frame on each side by the jaw of the tail piece of the main frame, that casting has a bearing on the faces 2 on either side of the tongue. This prevents any relative tilting of the main and truck frames, and holds the two frames in vertical alinement at all times.

The front pair of wheels of the truck are the regular 36 in. tender truck wheels and are used with the tender axle and oil boxes without change. The rear wheels are made 45 in. in diameter in order to accommodate the booster gearing and attachments.

The truck is carried by semi-elliptic springs placed over each axle box and equalized in the ordinary manner, with an equalizing bar between them.

At the same time, the four drivers on each side are equalized together, and cross-equalized at the front with the leading truck so that the whole locomotive is carried on an essentially three-point support.

The tail piece of the rear truck takes the rear draft pin at a point 56 in. back of the center of the rear axle, and also the radial buffer between the engine and tender. It also has the bearings on which the boiler is carried. These are shown at 3 in the truck engravings. As will be seen from the engraving of the side view of the truck, these two bearings are located just back of the center of the rear wheel of the truck and are set on the arc of a circle whose center is at the center of the draft pin in the tongue.

The boiler being rigidly attached to the main frame swings with it, and the long over hang which it has back of the rear pair of driving wheels, causes it to have a considerable lateral movement relatively to the truck on curves, which at this point of support has its center nearly coincident with the center of the track. This side motion of the firebox on curves is permitted by the roller bearings upon which it is supported.

This side motion of the boiler requires that the cab should be supported by and attached to it. This is effected by carrying it on heavy cast steel brackets which are, in turn, fastened to lugs cast on the foundation ring at the back and corners.

This leaves the truck beneath quite independent of the rest of the structure of the locomotive so far as its lateral movements and the accommodation of itself to curves is concerned.

As the ashpan is attached to the truck it, too, has no connection with the boiler but swings to and fro beneath the firebox and serves merely as a hopper into which the ashes may fall or be dumped. Its width is such that under the extremes of lateral travel of the firebox relatively to it, it still extends outside the limits of the latter. As it extends the full length of the firebox, its cubical contents are extraordinarily large, being 86 cu. ft. In fact it is so large as to afford ample accommodation for a man to work in it for the repairing of the grate shaking apparatus or the replacement of the grates. And, in order that it may be used for this purpose, a door is placed in the slope on the right hand side through which a man can enter.

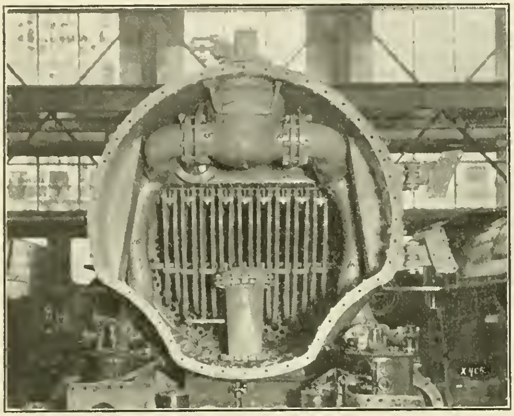
This large expanse of ashpan leaves an unobstructed opening between its edges and the foundation ring, so that there is always a free opening for the passage of air to the grates.

The object in using the four-wheeled truck was, primarily, to make possible a desired increase in the length of the grates. The length so obtained is 12 ft. 6⅛ in. inside the sheets, while the total length of the firebox over the outside sheets is 13 ft. 7 in., which is among the longest locomotive firebox on record. To have attempted to carry this great over hang with its accompanying load on the single-wheel trailing truck of a Mikado locomotive would have been simply an invitation to no end of trouble.

As it is, this great structure with a grate 12 ft. 6⅛ in. long and 8 ft. ¼ in. wide, is carried easily and without difficulty.

The boiler also departs somewhat from the ordinary construction in other matters than its mere size, the chief peculiarity being the rounding of the corners of the back head and throat. This is best seen in the reproduction of the photograph, where the side sheet is shown as coming down straight from a point just below the chownsheet and the slope of the back head is cared for by its own flanging, which has a depth of something more than 12 in. at the bottom, in excess of that at the top.

The grouping of the staybolts at the lower front corners is slightly changed from the common practice by a closer spacing. The distribution of these staybolts follows a usual practice of using a complete installation in the throat sheet and side sheets up to the crown sheet and then putting in four rows across the top at the front end to act as sling stays and then using rigid stays over the balance of the surface of the roof sheet.



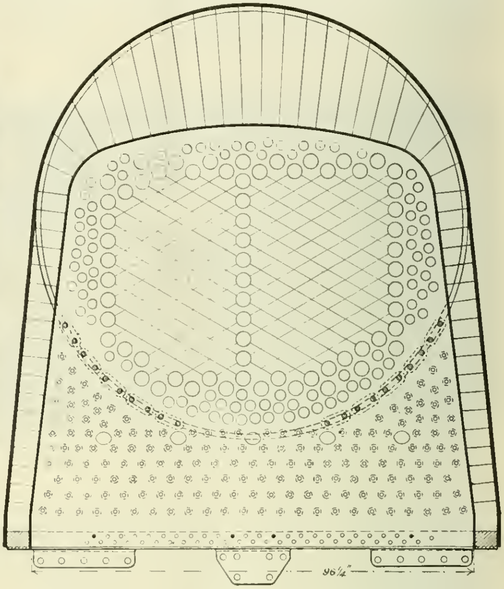
Front End Showing Arrangement of Throttle Valve, Steam Pipes and Superheater and Location of Air Pumps and Feedwater Pumps

By the use of cast steel cylinders, which will be referred to later, a very considerable saving in weight was effected, which was put into the boiler. This made it possible to use a shell whose first course next to the firebox is 94 in. in outside diameter. The shell is built up of three courses, the front one being 88 in. in diameter. The thickness of metal in the three being 1 1/16 in., 1 1/32 in. and 31/32 in. respectively.

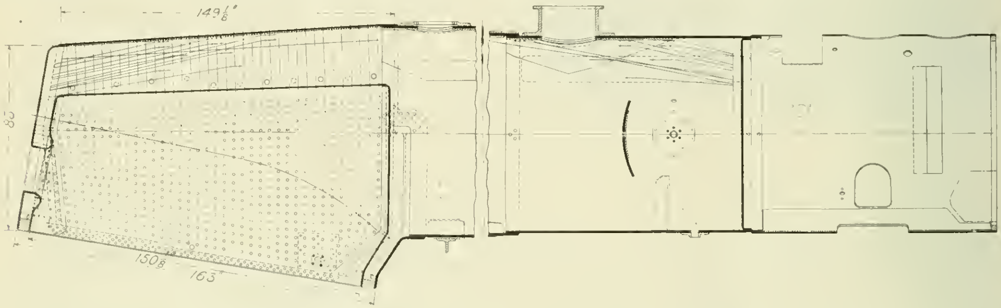
This large diameter of shell makes a corresponding radius of roofsheet possible, with the result that the inward slope of the side legs of the firebox is comparatively small, and, as will be seen from the cross-section, the conditions for the liberation of steam from the side sheets is almost ideal, for steam may rise from the bottom to the top without dragging along the surface of either sheet; a condition that will probably insure a maximum of water contact against the inner sheet.

The tubes are 20 ft. long, and the steam dome is set 8 ft. 5¼ in. back of the front face of the front tubesheet.

The cylinders are cast with a half saddle and are bolted together and to the bottom of the smokebox in the usual manner. But there the resemblance ceases. By making them of steel castings it has been possible to reduce the weight as compared with the ordinary cast iron cylinders by about 4,000 lbs., which relieved that much weight to be put into the boilers, as already stated.



Cross Section Through Firebox of 2-8-4 Type Locomotive

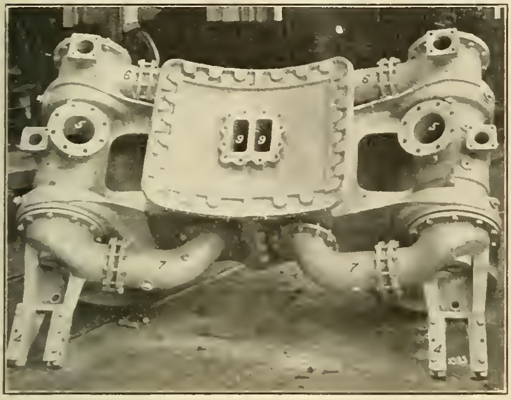


Longitudinal Section of Boiler of 2-8-4 Type Locomotive Built by Lima Locomotive Works, Inc.

Cast steel cylinders have been used before, but they have not been successful nor have they been generally used because of the difficulty in casting them. The complication of passages that had to be cored for the flow of steam was such that cooling cracks were developed to such an extent and caused the loss of such a large per centage of the work that it was not an economical proposition to use them.

The designers of this locomotive have, however, swept all precedents aside and quite discarded the conventional form of cylinder and half saddle, and have laid out a combination that is a mere box or shell, with no passages or partitions whatever, and then bolted all of their steam and exhaust pipe connections to the outside.

Before placing such a pair of cylinders on this engine an experimental pair was made and tested under pressure, and then the pattern was modified to meet the requirements as indicated by this investigation.

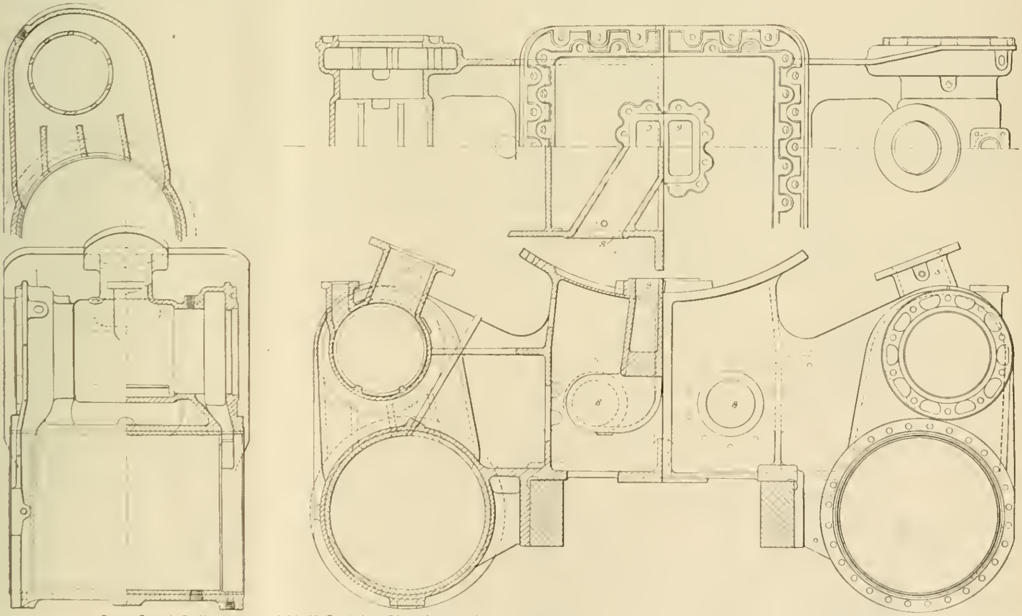


Cast Steel Cylinders With Exhaust Pipes in Position

elevation of the cylinder the simplicity of the design is still further emphasized. There is nothing but the shells of the steam chest and cylinder with the thin box of a saddle whose metal is 1 in. thick, and which carries only the two cored passages from the front and back faces to the exhaust opening.

Steam enters at 5 from the outside steam pipe and flows directly down through this straight connection, which is 8 in. in diameter to the center of the steam chest. When it has done its work it is exhausted at the ends of the steam chest and flows out through the pipes 6 and 7 at the front and back ends respectively to the openings 8 in the front and rear faces of the saddle, only that at front being shown in the horizontal section. These openings at the front and back lead into a passage that curves upward and when the movement of the steam has been directed toward the exhaust openings 9, they are brought together. This arrangement has not only produced a cylinder and half saddle that is easily cast with no danger of foundry losses, but one in which the flow of live and exhaust steam is through straight passages involving a minimum loss of live steam pressure and insuring the minimum of back pressure in the cylinders. Of course both the cylinders and the valve chests are bushed with cast iron so as to secure a proper wearing surface for the pistons and valves.

And now in the conducting of the steam from the boiler to the cylinders we encounter another novelty introduced in the No. 8000. It is to be found in the whole arrangement of the superheater and the placing of the throttle valve in the smokebox in front of the stack; in the location of the superheater between the throttle so that it is



Cast Steel Cylinders and Half Saddles Showing Exhaust Nozzles and Steam Intake of 2-8-4 Type Locomotive

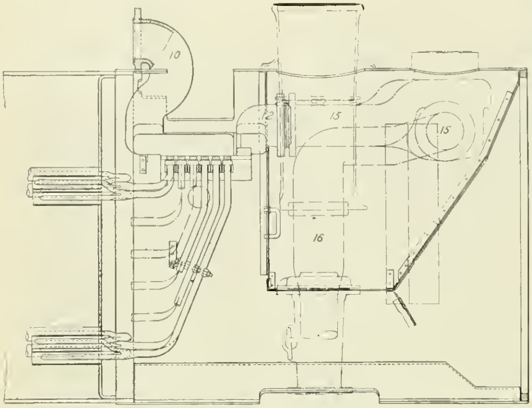
This box-like construction is clearly shown by the reproduction of the photograph of the assembled cylinders in which the parts in the foreground are those at the back end and the projecting brackets are those used for carrying the valve stem guides.

Referring to the line drawing of the half section and

filled at all times with steam, and thus renders possible the use of superheated steam in all of the auxiliaries.

The steam dome is located, as already stated, 8 ft. 5¼ in. back of the front tubesheet. It stands centrally on the top of the boiler, and is a steel casting. The outlet, however, has an offset and opens with its center line 15 in.

to the left of the center line of the boiler. From this opening the outside dry pipe runs forward and turns down through an elbow 10 into the top of the superheater header at 11, as shown in the end view of the superheater connections. After passing through the superheater it emerges at 12 and enters the throttle dry pipe 13, in which there is a side opening, 14, from which superheated steam is drawn for the auxiliaries. From the pipe 13, the steam passes through the throttle valve to the

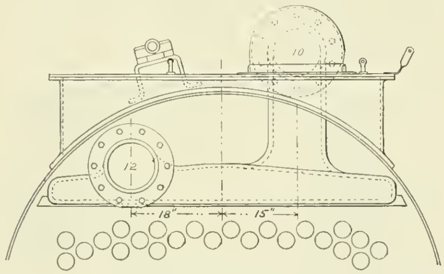


Longitudinal Section of Smokebox Showing Arrangement of the Superheater and Throttle

side outlets 15, and thence down through the steam pipes 16 to the cylinders.

The throttle casing, as will be seen from the reproduction of the photograph, is, together with the throttle dry pipe and the side openings, a single casting.

The Type E superheater used also presents a departure from current practice, though it cannot be said to be a distinct novelty, in that instead of the usual 5-in. flue with a double return flow of the steam there is used a 3½-in.



Section of 2-8-4 Type Locomotive Showing Dry Pipe and Superheater Connections

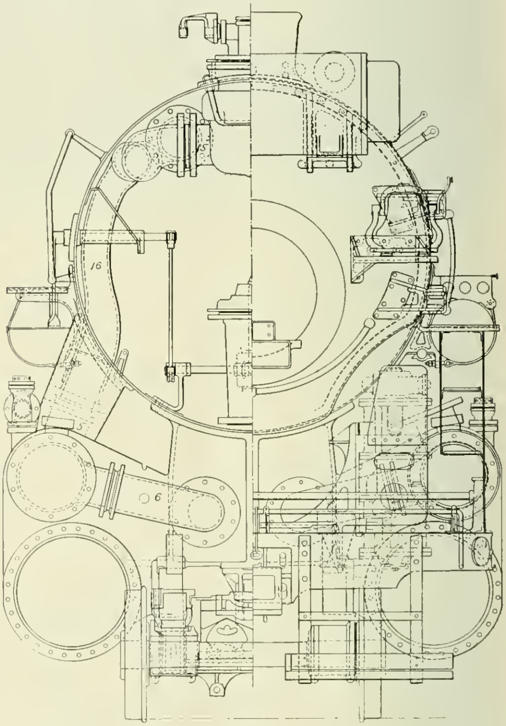
flue containing a single superheater return and, instead of a small number of flues grouped in the upper part of the boiler, there are 204 such flues and but 90 of the ordinary 2¼-in. tubes; and these are at the edges and across the top, filling in the interstices of the sectional area of the boiler where the 3½-in. flues could not be placed, and thus adding to the heating surface.

The opening for the superheater header in the smokebox has a fore and aft measurement of 18 in., and one across the boiler of 69½ in. so that the header and bolts are accessible from the top. And, as will be seen from the front view showing the superheater units, they are easily accessible for removal when the netting has been taken out.

Owing to the large diameter of the shell, clearances were not sufficient to place the air and feed-water pumps on the sides in the usual position. They have, therefore, been set back of the front bumper and beneath the smokebox, which has been indented on each side, as seen in the front elevation and view, so as to accommodate these auxiliaries.

Without attempting to exhaust the novelties on this new design there is one other that is deserving of attention, and that is the construction of the main and side rods.

Heretofore, the main crankpin has been called upon to sustain the total thrust of the cylinders on its outer bearing, which has contributed to heating, especially in the case of engines just out of the shop, and the subsequent cracking or breaking of pins in service.



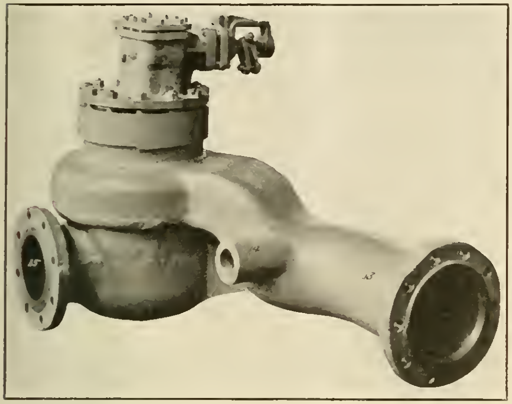
Front Elevation of 2-8-4 Type Locomotive Built by Lima Locomotive Works, Inc.

The new design of rods used on this engine relieves the main crankpin of 25 per cent of this thrust, in the case of an eight-coupled locomotive, by transmitting all of the power absorbed by the rear pair of drivers, directly to the crankpins in those wheels from the main rod.

The method by which this is accomplished is a direct development of the floating bushing already extensively used and is clearly illustrated by the accompanying engravings.

The stub end of the pin end of the main rod is forked and between the legs of this fork the side rod leading to the rear drivers is placed; while into the fork itself a steel bushing, 17, is pressed. This bushing has three outside diameters of 13¼ in., 13 in. and 12¾ in. The largest and smallest of the three fit and are pressed into the outer and inner legs of the fork of the rod respectively.

The central diameter serves as a bearing for the brass bushing, 18, which is fitted into the side rod. Between the steel bushing in the main rod and the outer bearing of the crankpin, there is a floating bushing, 19, of the customary type, which is so held in place that it may be removed and replaced without taking down the rods, so that the labor of repairing this item is reduced to a minimum.



Throttle Valve Casing

The side rods leading to the two forward pairs of driving wheels are set upon the inner bearing of the main crankpin in the usual manner and are of the ordinary construction except that they have no rearward extension.

In operation the total thrust of the main rod is first put upon the steel bushing, 17, from which the rear side rod takes off enough to turn the rear drivers, leaving the balance, or approximately 75 per cent of the whole, to be carried by the floating bushing, 19, and the outer bearing of the main crankpin.

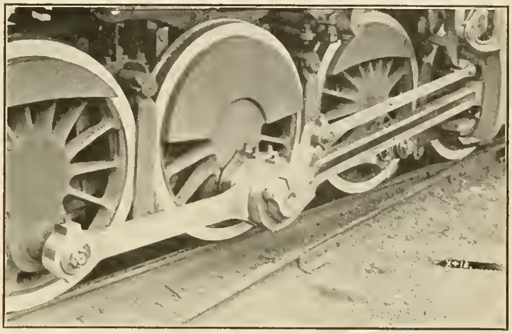
The efficiency of this arrangement has been demonstrated by its rather unusual action for the new engine was, after a short breaking in, put into service and has been run for weeks without any heating of the main crankpin.

In designing the locomotive allowances were made for adjustments that might have to be made as the result of service trials. For example, in order to avoid repeated replacements of exhaust nozzles in order to determine the diameter most suitable for the locomotive a variable nozzle of the type used on the Paris Lyon & Mediterranean Railway was installed, but instead of placing the regulating handle in the cab, there is nothing on the outside except the lever marked 20 in the side view. This is adjusted for experimental purposes and when the best location or diameter of nozzle has been determined the design will be discarded and a fixed nozzle substituted.

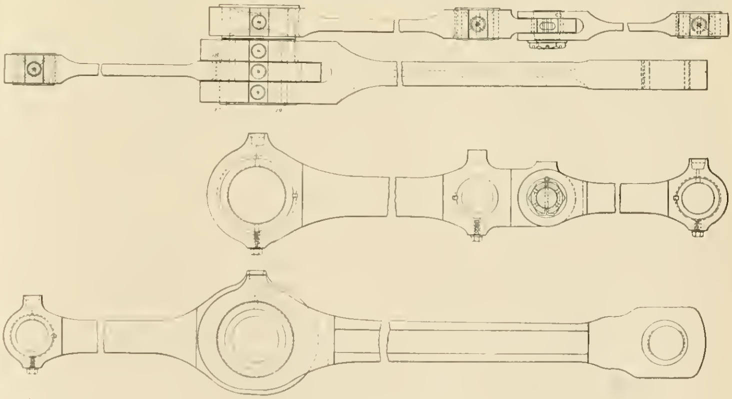
The use of a limited cut-off has also been adopted. This has been placed at 60 per cent of the stroke, as the point where, with a boiler pressure of 240 lbs. per sq. in., the torque will be most uniform, a matter that will be discussed in detail in a future issue.

The auxiliary ports by which this is accomplished are not the same at the two ends of the cylinder. These ports are 2 3/16 in. wide but the one at the front is increased in width 7/16 in. towards the center of the valve chamber, thus delaying the point of cut off at the front and making it 63 per cent to the 60 per cent at the rear. This has its greatest effect at slow speeds, but as the speed increases its effect decreases until it finally becomes a negligible quantity.

In service work the locomotive is showing a remarkable increase of efficiency as compared with the No. 8000 and other locomotives of the Mikado type, details of which will be published in a future issue. The various novel parts of the design are protected either by Letters Patent or patents applied for.



Forked Connecting Rod for Transferring Thrust Directly Back to Rear Driving Wheels



Main and Side Rods Showing Bushings for Taking Thrust to Back Driving Wheels of 2-8-4 Type Locomotive

The principal dimension of the locomotive are as follows:

Dimensions of 2-8-4 Type Locomotive

Cylinder diameter	28 in.
Piston stroke	30 in.
Valves, piston type, size	14 in.
Maximum travel	8¾ in.
Outside lap	2 7/16 in.
Exhaust clearance	1/16 in.
Lead in full gear	¼ in.
Cut-off in full gear, per cent	60

Weights in working order:	
On drivers	248,200 lb.
On front truck	35,500 lb.
On trailing truck	101,300 lb.
Total engine	385,000 lb.
Tender	275,000 lb.
Wheel bases:	
Rigid	16 ft. 6 in.
Driving	16 ft. 6 in.
Total engine	41 ft. 8 in.
Total engine and tender	82 ft. 6 in.
Wheels, diameter outside tires:	
Driving	63 in.
Front truck	33 in.
Trailing truck	36 in. and 45 in.
Journals, diameter and length:	
Driving, main	12 in. by 14 in.
Driving, others	11 in. by 13 in.
Front truck	6½ in. by 12 in.
Trailing truck	6½ in. by 12 in. and 9 in. by 14 in.
Boiler:	
Type	Straight top
Steam pressure	240 lb.
Fuel, kind	Bituminous
Diameter, first ring, outside	88 in.
Firebox, length and width	150⅛ in. by 96¼ in.
Height mud ring to crown sheet, back	60½ in.
Height mud ring to crown sheet, front	91¼ in.
Arch tubes, number and diameter	5, 3½ in.
Combustion chamber, length	None
Flues, number and diameter	90, 2¼ in.
Tubes number and diameter	204, 3½ in.
Length over tube sheets	20 ft.
Tube spacing	¾ in.
Flue spacing	¾ in.
Net gas area through tubes and flues	1,536 sq. in.
Grate area	100 sq. ft.
Heating surfaces:	
Firebox, incl. arch tubes	337 sq. ft.
Tubes	1,055 sq. ft.
Flues	3,718 sq. ft.
Total evaporative	5,110 sq. ft.
Superheating	2,111 sq. ft.
Comb. evaporative and superheating	7,221 sq. ft.
Tender:	
Style	Rectangular
Water capacity	15,000 gal.
Fuel capacity	18 tons
Weight proportions:	
Weight on drivers ÷ total weight engine, per cent	64.2
Weight on drivers ÷ tractive force	3.58
Total weight engine ÷ comb. heat. surface	53.3
Boiler proportions:	
Tractive force ÷ comb. heat. surface	9.61
Tractive force × dia. drivers ÷ comb. heat. surface	605
Firebox heat. surface ÷ grate area	3.37
Firebox heat. surface, per cent of evap. heat. surface	6.60
Superheat. surface, per cent of evap. heat. surface	41.4
Tube length ÷ inside diameter	74.5
Comb. heat. surface ÷ grate area	72.2

Ton-Mile Traffic Sets New Record

The volume of freight carried by the railroads during the first two months this year was the greatest ever handled by them during any corresponding period on record, according to reports of the Bureau of Railway Economics.

In net ton miles, it amounted to 70,560,495,000, an increase of two-tenths of one per cent over the corresponding period in 1924 which marked the previous high record, and an increase of three-tenths of one per cent over the same period in 1923. It also was an increase of 3.9 per cent over the same period in 1920.

In the Eastern District freight traffic during the two months period was a decrease of six-tenths of one per cent under last year.

In the Southern District it was a decrease of five-tenths of one per cent.

The Western District showed an increase of 1.6 per cent.

For the month of February alone, however, freight traffic amounted to 33,552,280,000 net ton miles, a decrease of 2,427,790,000 or 6.7 per cent under the same month last year. This was, however, an increase of 2.8 per cent over February two years ago and 1.8 per cent over 1920. All districts reported decreases compared with February, 1924, the Eastern District showing a decrease of 7.2 per cent, the Southern 5.0 per cent and the Western 6.8 per cent.

Miles Per Day Less

The average daily movement per freight car in February was 26.9 miles, a decrease of three-fifths of a mile compared with the same month in 1924, but an increase of 2.1 miles above that for February, 1923. It was also an increase of two-fifths of a mile above the average for January this year.

In computing the average movement per day account is taken of all freight cars in service, including cars in transit cars in process of being loaded and unloaded, cars undergoing or awaiting repairs and also cars on side tracks for which no load is immediately available.

The average load per freight car in February was 27.2 tons, two-fifths of a ton less than that for the same month last year and one ton less than in 1922. Compared with January, 1925, it was a decrease of four-fifths of a ton.

Railway Accidents Steadily Declining

The last two years have been record years so far as the safety of railroad passengers and employees is concerned, according to R. H. Aishton, President of the American Railway Association, in an address before the fifth annual meeting of the Safety Section of that organization held in Chicago, April 28-30. He said, in part:

"In 1924 alone, the railways of the United States transported 931,000,000 persons, nearly nine times the population of the United States, with fatalities to only 149 of that number. That is, for every fatality during the year, the railroads safely carried 6,314,000 persons, nearly one and one-half times the number of men that constituted the armed forces of the United States during the World War.

"At the same time the number of injured was fifteen per cent less than the average for the previous four years, and the smallest number injured during any one year since 1901.

"The number of railway passengers who lost their lives in 1924 was twenty-three per cent less than the annual average for the years 1920 to 1923, inclusive. Compared with 1923, there was an increase of eleven persons who lost their lives. Fatalities due to train accidents showed a decrease in 1924, compared with the previous year, but there was an increase of twenty persons in the number of fatalities due to passengers getting on or off cars.

Safety Campaigns Have Been Successful

"A person today is in far less danger speeding across the country at 60 miles an hour on a railway train than he is crossing a street in any of the principal cities of the United States. In New York City alone during 1924, 963 persons were killed by automobiles and in Chicago, there were 560 killed. In Philadelphia, motor fatalities numbered 270; Detroit, 302; Cleveland, 214; St. Louis, 192; Boston, 137; Pittsburgh, 154, and Los Angeles, 263.

"In 1920, there were 1,273 fatalities at grade crossings as a result of automobile accidents, or 137.9 fatalities for every million vehicles registered. In 1923, there were 1,759 fatalities or 116.6 for every million vehicles and in 1924 there were 1,688 fatalities or 95.4 for every million vehicles.

"This situation offers a tremendous field for constructive work in saving human life and no more effective effort can be put forth by the Safety Section of the American Railway Association than in that field."

Shops and Locomotive Terminals

Reports of Committee of the American Railway Engineering Association at 26th Annual Convention

General Layouts and Designs of Car Shops

The committee has pursued this year the study of the subject of general layouts and designs of car shops with the view of presenting, for your consideration and approval, certain definite recommendations that would be useful for the guidance of those confronted with the problem of providing suitable buildings and facilities for handling heavy repairs to freight train cars.

Freight car repairs are divided into two general grades, viz: light or running repairs, and general overhauling or classified repairs. Light or running repairs is that class of work accruing from current wear and breakage such as is usually taken care of in transportation yards under blue flag or, where the damage is sufficient to necessitate switching the cars out of the train, is handled on the adjoining rip tracks. Classified repairs are of a different nature and involve the work of restoring the car, as a whole, to first class condition after a long period of service. It would be unreasonable to recommend enclosed shops for the former class of repairs because the floor space required would be out of proportion to the amount of work done while, on the other hand, for classified repairs on account of the larger volume of work per car and the possibility of systematizing and specialization in the various operations, there may be sufficient advantage to warrant the provision of enclosed shops. Therefore, it is for shops in which are to be handled the heavy class of repairs that your sub-committee wishes to make recommendations.

Before laying definite plans for shops it is well to consider the policy in force with respect to general repairs. Generally speaking, except for smaller roads, or where the system radiates distinctly from a central point, it is advisable to have a plurality of car shops and it may develop that the traffic demand for cars from these various points may permit of a certain amount of specialization as to type and class of cars. Decentralization to this extent is to be recommended for several reasons: It minimizes the effect of labor difficulties; decreases empty car haul; permits specialization in certain classes of equipment and the immediate delivery of reconditioned cars at point of loading, and it may facilitate the use of lumber, steel or other supplies without excessive haul.

The advisability and practicability of shopping cars by series or classes have become recognized and most of the obstacles in this respect have now been overcome to the extent that the method has become quite general in its application to heavy freight car repair work. The same is also true in regard to the progressive system of shop operation. It has been demonstrated conclusively that with a reasonable volume of operation and a properly organized shop force, there are greater possibilities for economy and efficiency with this method than with any other that has yet been devised. This method permits of systematic delivery of material at defined intervals of time and to designated points; it is conducive to specialization of the work by groups or individuals, which is a large factor in production; it simplifies supervision and allows close control of output; as the workmen become familiar with the particular task to which assigned the chances for personal injury are greatly reduced; it lessens the necessity for multiplicity of tools and fixed equipment such as scaffolds, hoists, etc. The only objections to the adoption of the system is the effort necessary to collect cars of the same series in sufficient numbers to make the operation practical, and the possibility that the work on some individual car might retard the progress of the others. However, it would seem that, except for the smaller roads, these objections might be overcome by arranging for the recall of cars sufficiently in advance and by systematic inspection prior to placing the cars in position for the shop.

It is impossible to prescribe definite formula as to capacity and output for a particular shop or for a group of shops, however, certain general statements can be made on the subject which should be of service when dealing with the problem. It is a fairly recognized fact that there is a definite cycle for freight train car repairs and it has been determined that the average freight car requires a heavy repair, or general overhauling, after a period of service of approximately eight years. This factor will vary somewhat for different classes of equipment and types of construction. One party having charge of refrigerator cars almost exclusively, informs us that the cycle for that type of cars is five years, which statement is substantiated by a carrier having a large ownership in the same class of equipment, in that their experience indicates a five- or six-year term of service, and for stock cars also, while box and open cars will run two or three years longer. Some eastern roads having a large ownership in all steel cars are experiencing a turn over factor of approximately five years. It is interesting to note in this respect that the cycle is often more than double with similar all steel equipment operating closely within the confines of certain sections in the southwest where the relative humidity is quite low.

Therefore, it is to be noted that, with some intimate knowledge of the equipment to be handled, a prediction may be made of the probable annual turn over. If the repair cycle approximates five years then the measure for capacity would be 20 per cent of the total number of cars owned or, if based on an eight-year cycle, the measure would be 12½ per cent, and so on, for various factors. The situation is modified to some extent by the policy of acquisition or purchase of new equipment. If there is a liberal policy as to retirement of old equipment with a like number of new cars purchased then the total shop capacity may be correspondingly reduced, but on the other hand, if, on account of financial restriction, or otherwise, but few retirements are made, then a capacity should be provided for the full factor determined.

The capacity of a particular shop should be determined with full consideration to the seasonal demand for the particular class of cars to be repaired. For instance, it may develop that an annual output of 3,000 cars of a certain class are required. On a uniform operation throughout the year this would represent an output of about 10 cars per working day, while, if it were necessary to turn out 75 per cent of the cars within a dull traffic period of six months, then it would be necessary to provide for an output of 15 cars per day.

There are many variable factors involved in determining the car capacity of a shop to give a certain output. The principal features are: The class of equipment to be repaired, the nature of the work done, the facilities at hand, and the intensity of the operation. From information furnished by a number of carriers where careful studies have been made on productive operation, we would infer that an average daily output of 10 cars could be expected from a capacity of 60 to 80 cars. This assumption is based on a time element of from 6 to 8 working days per car where ample facilities and proper organization prevail, and with the understanding that stripping would be done outside the shop.

The length of track to be allowed to each car is an item that depends upon the method employed in working the shop. In the report made by this committee in 1921, previously referred to in this paper, it was suggested that 60 ft. be used as the basis for estimating car capacity, where it was anticipated that the trucks would be repaired on the same track with the car. However, such an operation could not be carried out under a strictly progressive system, as the trucks would hinder the movement of the cars through the shop. It is suggested that where it is contemplated to use the progressive system in the shop being planned that a minimum of 45 ft. be used as the track space necessary for car. Greater distance should be employed in some portions of the shop where it would be necessary to allow working room around ends of the car.

The size of the main or erecting shop is influenced to a large extent by the system to be followed with respect to stripping of old cars and the painting of the finished cars. It is contemplated to do either or both inside the main building then of necessity a larger floor space will need be provided. From information collected it is believed that the general practice particularly for large operations is to do at least the rough stripping outside on tracks set aside for that purpose. This eliminates the litter from the shop floor, saves labor of handling the debris, as it is usually burned or scrap piled at place of stripping, and released valuable floor space for repair work. For the painting and stenciling operation, there seems to be no universally adopted place for doing the work unless it be out of doors. A few roads paint the cars in the repair sheds, but the majority of recommendations received were in favor of separate buildings for the purpose, which leads the committee to believe that such would be recommended, particularly since spraying has now come into general use. A paint spraying machine used in the erecting shop may produce very disagreeable working conditions for the repair shop men, and while painting outside in favorable weather is desirable from the workmen's standpoint, there is a large amount of damage experienced from rain and frost where the work is unprotected. For these reasons, your committee recommends that consideration be given to this feature as it is deemed advisable to provide a separate building for painting, particularly in localities where cold, damp weather prevails. Simple and inexpensive construction can be employed in this structure but special attention should be given to ventilation, and in the case of cold and damp climates sufficient heat should be provided to insure quick drying and to afford as rapid a turn over as possible.

Attention is also called to the two methods practiced in respect to repairing trucks. One method is to run the trucks out at the end of the car, doing the repair work on the same track with the car, while on the other the trucks are removed to a special truck shop or space set aside for truck work while the car body is placed on shop dollies or a set of repair trucks for movement through the shop. Obviously, more space per car is required for the former practice than for the latter.

As to the physical features, equipment, general layout of main shop and subsidiary departments, your committee after due deliberation, has concluded that it is impractical to attempt to develop a plan or layout that could be offered even as a guide because actual developments differ so widely as to topography and outline of space to be occupied, that each case presents a distinct problem within itself, however, there are certain basic features that can be prescribed. In this respect your committee has collaborated with a committee of the American Railway Association, mechanical division, instructed to report on a similar subject and they have joined with us in making certain basic recommendations. The report of that committee which was made at the convention of that association June 11-13, 1924, reads, in part, as follows:

1. The distance from the center line of the outside car repair track in a car shop building to any projection on the outside wall should be not less than 11 ft.

2. The distance center line to center of repair tracks that have a standard gage material track between them should be not leess than 22 ft.

3. The distance center line to center line of repair tracks that do not have a material track between them should be not less 18 ft.

4. The distance center line to center line of car repair tracks where a row of columns is located between the tracks, should be not less than 22 ft, and in no case should the distance from face of columns to center line of adjacent repair track be less than 10 ft.

5. The minimum distance from the top of rail to bottom of traveling crane bridge in car shops that do not lift cars over each other, should be 23 ft.

6. Car repair shops should be arranged so that cars can be switched from both ends.

7. Material tracks in car repair shops and yards should be standard gage.

8. That portion of the car repair shop floor, between the outer rails of adjacent repair tracks having a material track between them should be planked or paved, and suitable planked or paved roadways should be extended out into material yards, to facilitate trucking and the use of tractors for handling material.

These general features are illustrated by the adjoining sketch. Your committee concurs in this and offers it as a joint recommendation.

Inquiries have been made of a number of carries as to the advisability of installing overhead cranes in connection with heavy freight car repair work and the expressions of opinions seem to indicate that cranes are to be recommended, particularly for new shops, as the additional cost is not unreasonably large where the investment has been undertaken to house repair tracks and facilities. The necessity, however, is more pronounced in connection with steel than with wooden cars. However, the increasing acquirements in cars of the all-steel and composite construction gives further argument for the installation of cranes in new plants. Cranes of 15-ton capacity seem to be most popular, particularly where they are used in longitudinal shops, in which more than one crane is installed per bay. It gives ample capacity for lifting one end of a car to allow the truck to be run out or set under the car body, and to handle the heaviest part necessary in connection with freight car repair work. If it becomes necessary to lift a complete car, two cranes can be used jointly. However, in work on heavy steel cars where only one crane is to be employed, it may be advisable to use a crane of greater capacity. Under such circumstances, a capacity of 25 tons is considered ample, with 30 tons as the maximum that would be required under any circumstances.

It is optional, of course, with the carrier as to the type of construction to employ for the building. Steel frame with brick or tile walls is preferable, particularly in cold climates, although corrugated iron may be used, thus reducing construction costs. Wooden structures, except for the slow burning mill construction with brick or tile walls, are not recommended because of the fire hazard.

Large glass areas should be provided, particularly in the roof as well as side walls, in order that ample illumination is available. Natural lighting should be augmented with plenty of artificial illumination for efficient work on gloomy days.

Good paving, while not absolutely essential, is recommended because it is felt that reduced maintenance from a properly constructed floor and the benefit from the orderliness possible with a good floor will go a long ways towards offsetting the additional first cost necessary to provide it. Under any circumstances, it is recommended that the portion of the shop floor between each pair of repair tracks, having a material or supply track between them, should be paved or planked to facilitate the use of tractors and trailers or hand trucks employed in the handling of material and supplies to the car.

The question of heating car repair shop buildings has been considered and discussed. Heat is desirable but not absolutely essential; however, it is the thought of your committee that it will be of assistance in obtaining consistently high production throughout the year, particularly in territories where climatic conditions are severe.

Compressed air and electric power are very essential to a car repair shop operation and full facilities should be provided in this respect. Outlet boxes should be placed at frequent intervals to insure at least one for every car spot.

In conclusion, your committee wishes to offer for your consideration and approval the following as recommendations for general practice for inclusion in Manual of the association:

Recommended Practice for Freight Car Repair Shops

1. The distance from the center line of the outside car repair track in a car shop building to any projection on the outside wall should not be less than 11 ft.

2. The distance center line to center line of repair tracks that have a standard gage material track between them should be not less than 22 ft.

3. The distance center line to center line of repair tracks that do not have a material track between them should be not less 18 ft.

4. The distance center line to center line of car repair tracks, where a row of columns is located between the tracks, should not be less than 22 ft., and in no case should the distance from face of columns to center line of adjacent repair track be less than 10 ft.

5. The minimum distance from the top of rail to bottom of traveling crane bridge, in car shops that do not lift cars over each other, should be 23 ft.

6. Car repair shops should be arranged so that cars can be switched from both ends.

7. Material tracks in car repair shops and yards should be standard gage.

8. That portion of the car repair shop floor between the outer rails of adjacent repair tracks, having a material track between them, should be paced or planked and suitable paved or planked roadways should be extended out into material yards to facilitate trucking and the use of tractors for handling material.

9. In shops where cranes are not employed the overhead clearance, measurnig from top of rail should be not less than 20 ft., door openings excepted.

10. Except where otherwise prescribed by law, repair track door openings should not be less than 13 ft. wide by 17 ft. high.

11. Suitable provision should be made in the formulation of plans to provide for reasonable extension of all buildings and facilities.

12. Suitable means should be provided for prompt and economical handling of materials and supplies through the application of cranes, hoists, mono-rails, supply tracks and roadways for tractors and trailers.

13. It is recommended that firepoof or slow burning construction be employed for the building structures.

14. It is recommended that the roof and side wall construction be such as to give maximum natural light and ventilation.

15. Ample artificial illumination is recommended.

16. Heat is recommended, for the colder climates.

17. Separate building is recommended with excess heat and good ventilation for painting and stenciling for cold or rainy climates.

The Ventilation of Engine Houses

The adequate ventilation of engine houses is a problem more dependent upon care given the various details of design, and the attention given by operating officers to handling locomotives in such a way that ventilating provisions will not be overtaxed, than to the use of any one particular character of design, or to the provision of any special mechanical equipment.

It is the opinion of the committee that if the recommendations herein made are incorporated in engine house design, generally, and if care in operation is taken to secure full advantage of same, ventilation conditions will be materially improved. All of the features presented for consideration are in use at different locations and there is, therefore, no radical departure or change from present practices recommended, but it is confidently expected that an intelligent combination of these details of design, coupled with the careful use of facilities provided, will make a very great improvement in ventilation conditions in engine houses.

There are two principal causes of impure air in engine houses as follows:

(1) The escape of smoke from smoke stacks.

(2) The escape of steam when boiler is blown off.

If care is taken in operation to see that these causes are held to a minimum, reasonable provisions in the design for ventilation will not be overtaxed. It is not an uncommon occurrence, however, to see locomotives emitting quantities of black smoke when the smoke stack is not spotted under the smoke jack in the roof. Also, not infrequently, steam is blown off directly into engine house without making connection to piping provided for the purpose of conveying this steam into the outside air, or to boiler washing system.

It is assumed for the purpose of this report, that in the case of new installations, engine houses generally are constructed in accordance with the principles set forth in the Manual, so that, for example, stalls are of sufficient depth to provide proper working space with doors closed.

The following recommendations have particularly to do with ventilating features, although they reiterate certain features of previous reports which have a particular bearing on ventilation.

Smoke Jacks

Smoke jacks should be of the fixed type, at least 42 inches wide, of such length (preferably at least 12 feet) as to permit the locomotive stack to be spotted under the hood of the jack at all of the various positions of the locomotive, made necessary for the accomplishment of certain repair operations. The position of the jack in the roof should be established with the above condition in view and the elevation of the bottom of hood should be as low as the height of the locomotive will permit. The area of flue opening should be at least seven square feet. An annular space two inches in width should be provided around the flue. Smoke jacks should not have dampers. In moving locomotives into the house they should be spotted with smoke stacks under the jack as rapidly as consistent with safe handling, and should always be kept in such position while under fire.

Steam Blow-Off

Provision of a proper system of piping for blowing off steam from boilers should be made in every engine house. Where possible the steam blown off should be used for heating purposes in connection with a boiler washing system, but in all cases discharge should be made outside the limits of the engine house. A ventilator of standard design and at least 18 inches in diameter should be placed in the roof on the center of each stall, and as nearly as possible over the center of the steam dome of locomotives handled. If regular blow off piping is temporarily out of service, arrangements should be made to blow off through portable pipe into this ventilator and the blowing off of locomotives without such provision should be absolutely prohibited.

The features above mentioned will, as heretofore stated, reduce the necessity for other ventilation provisions, but, as with the best of care in operation, some smoke and steam will escape, the following additional recommendations are considered essential.

As modern engine houses have stalls, generally, one hundred feet or more in depth, at least one break should be made in roof and, if desirable, complete monitor may be installed. Such breaks or monitors should be provided with pivoted sash, or of pivoted sash and fixed louvres.

Roof framing should be such that the rafters directly supporting the sheathing, or other roof surface, are in radial lines, and without pockets, so as to permit the free passage of smoke to eaves. At the eaves directly under roof sheathing, if climatic conditions will permit, a continuous opening of four to six inches should be provided, to permit the escape of smoke and steam, particularly at breaks and in monitors.

Large windows should be provided in the outer walls with a generous provision of ventilating sections. As near a continuous row of these ventilating sash as practicable should be provided along the top of windows.

The relation of the heating system to the ventilation of the engine house is, of course, apparent. The provision of a hot blast heating system, with supply of air taken exclusively from outside the house, and circulation by means of underground ducts, with outlets in pits and along the outer wall just above floor level, is recommended for general use. Such a system, designed for frequent air changes, will result in the rapid clearing of the atmosphere in the house, even under unfavorable conditions. The use of this equipment during the summer months will also clear the atmosphere at that time, and materially lower the temperature of the house.

The provision of special smoke jacks with a system of ducts and induced draft for the collection and disposal of smoke from locomotives which has been installed in certain locations by a number of roads is not recommended for general use on account of the prohibitive expense involved in making such installation. The use of such a system should be confined generally to engine houses in congested city districts where the collection and disposal of locomotive smoke is necessary to meet local requirements.

The Engineer as an Executive

By JULIUS KRUTTSCHNITT, Chairman, Executive Committee Southern Pacific Company

Second Section of Paper Read Before Engineering Societies in New York

(Continued from April Issue)

Trend of Current and Future Economic Development

We now touch on a study of the trend of current and future economic development:

Much idle time and fuel can be saved by carefully designed engine terminal facilities, such as hot-water boiler-washing plants, well located supply tracks, etc., and above all ample shops and modern tools to make repairs quickly.

Additional shops and tools provided at El Paso on the Southern Pacific Lines have reduced the average time in shops of locomotives 25 per cent, the effect of which is to add 33 per cent to the number of locomotives assigned to that Division.

On a division operated with consolidation locomotives where water is exceptionally good, 16,000 pounds of fuel are saved per locomotive per annum by the installation of a hot-water boiler-washing plant.

Such improved facilities, while requiring large capital outlay, will increase the productive time of locomotives.

The burning of fuel in large terminals and shops should be centralized as far as practicable in order to eliminate machinery starting and stopping losses. Through free use of individual electric motors on large tools and groups of small tools the waste of running long lines of shafting and of operating tools needlessly when but one or two on the line are used, can be eliminated and substantial economies can be effected in the 16,000,000 tons of fuel consumed on railroads in shops, stations, etc., etc. Twenty per cent of the power in a large railroad shop was saved by eliminating steam-pipe losses and 13 per cent more by abandoning long lines of shafting and many belts through substituting electric for steam power. The changes represented a saving of $120,000 per year.

In locations where electrical energy can be purchased at lower cost than it can be produced by the railroad, opportunities for substantial fuel savings are presented.

The effect of all of the factors influencing increased work obtained out of fuel on a system of over 11,000 miles was to increase the ton miles moved per pound of fuel 50 per cent from 1913 to 1924.

It is encouraging that the improvement in the work obtained from a pound of fuel is constant, but it is disappointing to reflect that we are indebted to European engineers for most of the improvements now in use on our locomotives. This is the case with the improved outside valve gear, superheaters and feed water heaters, some details of which, however, have been designed by American engineers, but nevertheless it is mortifying to admit that the principles underlying these devices were not first used in our country. The reason of course is that heretofore fuel has been so cheap and easily obtained with us that there was little inducement to pay much attention to its conservation; conditions have radically changed in the last few years, however.

The two principles affecting most profoundly the efficiency of stationary steam engines are compounding and condensing. Compounding alone may increase the efficiency of an engine 13 per cent, and condensing alone may increase it as much as 30 per cent, that is, condensing alone would increase the efficiency of fuel consumption of locomotives nearly as much as brick arch, superheater and feed water heater combined, which we have already seen amounts to 34½ per cent. Compounding, which was used in the United States, at one time very much more than now, will certainly come into use again; so that the combined effect of all the devices we have described, with compounding and condensing superadded, would be:

Brick arch when used has reduced fuel consumption to	91.0%
The superheater when added has reduced it to	72.8%
The feed water heater when added, to	65.5%
Using condensing engine may reduce it to	45.9%
Compounding may reduce it to	39.9%

Our European railroad brothers are fully alive to the advantages of using a condensing engine on the locomotive, as evidenced by descriptions that have appeared in the technical press in the past year or two.

Turbine Locomotives

Swiss Federal Railways, as announced by the Technical press of 1921 and 1922, are testing a 10-wheel type locomotive, with superheater, driven by a condensing steam turbine, located on locomotive frames in front of smoke box. It is claimed that tests so far show reduction of fuel consumption of 25 per cent compared with compound locomotives of usual construction, and very smooth running at high speeds on account of the reduction of heavy reciprocating parts.

Swedish State Railway has built a turbine locomotive. It is claimed that this locomotive, known as Ljungstrom Locomotive, shows a fuel consumption of about 50 per cent of that of a Pacific type locomotive, which it replaced.

The London and Northwestern Railroad has built an experimental locomotive driven by a condensing turbine which operates a generator, and the power is applied to the driving wheels through four electric motors of 275 horsepower each.

Electric Locomotives

Where electric current can be generated from water power, trains can be moved very cheaply, but where the current is generated in a steam plant the advantages are very much diminished.

Data given in United States Geological Survey Professional Paper No. 123 show that in eight large steam-electric plants studied in 1919 12.2 per cent of the energy in coal is converted into electric energy; transmitting this electric energy to the motors of an electric locomotive reduces the available power 9.9 per cent and this is further reduced in the motors to 8.4 per cent of the total original energy in the coal. The corresponding efficiency of a modern steam locomotive with arches, superheater and feed water heater is 8.1 per cent under favorable conditions. While under existing conditions the advantage may be more than indicated in favor of the electric locomotive, the spread is hardly enough to tempt capital to assume the expenses of interest, depreciation, tax and maintenance expenditures that would have to be incurred in changing from steam to electricity generated in a steam plant. The soundness of this conclusion was demonstrated by studies made of the Sierra Nevada and other heavy grades on the Southern Pacific, where trains on the former are lifted 6,854 feet in 86 miles. Assuming current generated in a steam station, the interest, taxes, depreciation on additional net plant required were found to be more than three times as great as the estimated savings to be obtained from electric operations.

Other considerations, such as smoke prevention, increasing capacity on heavy grades, may influence the problem, but we recall no instance of a change being made solely to save fuel where a steam generated current was used. The steam locomotive is by no means as obsolescent as its critics would have us believe. In an address published in the March, 1920, edition of the Journal of the American Institute of Electrical Engineers, a fuel consumption of 100 pounds per 1,000 gross ton-miles by electric locomotives is given as applicable "to conditions universally obtaining on regular profiles." Data published by the Bureau of Railway Economics in September, 1921, show that the muel consumption on 24,000 selected miles of steam railroad averaged but slightly over 100 pounds per 1,000 ton-miles. Embraced in this mileage were the New York Central, Illinois Central, Chesapeake & Ohio and St. Louis Southwestern. On 3,142 miles, or 60 per cent of Southern Pacific mainline mileage, the fuel consumption in the same month was approximately 100 pounds, while on the Salt Lake Division, 543 miles, the fuel record in October, 1921, averaged but 91 pounds per 1,000 gross ton-miles, for all locomotives. During the entire month of October, 1924, 62 Southern Pacific freight engineers held records of having moved 1,000 gross ton-miles with a fuel consumption running between 48 and 59 pounds per 1,000 ton-miles, under "conditions universally obtaining on regular profiles," or but little over half of what was considered a reasonable fuel consumption for electrically moved trains.

These are every-day performances, while we must remember that in the case of the Swedish experimental locomotive, and in records of electrically operated trains, the data relate either to experimental runs or to performance under exceptional conditions.

The performance of the modern steam locomotive in every day service without favorable stage setting is shown in the records of some American roads. On one of them, 26 super-heated consolidation locomotives showed in daily service on a run with long grades of 21 feet per mile an average consumption of 63½ pounds of coal per 1,000 gross ton-miles, ranging from 55.8 to 71.7.

Still more creditable to the steam locomotives and the men who drive them are the records of individual runners. Engineer A in two trips with trains of 2,809 tons consumed 48.7 pounds per 1,000 gross ton-miles; Engineer P in eight trips with trains of 2,863 tons consumed 58.2 pounds; Engineer R in fourteen trips with trains of 2,411 tons consumed 58.3 pounds.

Internal Combustion

These engines vary widely in thermal efficiency and weights per unit, thus:

	Weight per Brake Horsepower	Brake Thermal Efficiency
Automobiles	15 pounds	19.0%
Diesel four-cycle	370 pounds	35.0%
Diesel two-cycle	250 pounds	30.0%
Airplanes (Packard—recent press item)	1.04 lbs. per. H. P	

The use of the first type, except perhaps for short runs in exceptional conditions with light vehicles, is prohibitive on railroads, because although the automobile engine is two and one-third times as efficient as the steam locomotive the present cost of its fuel is ten times as great.

The Diesel engine, however, shows the highest thermal efficiency of any known engine. We have seen that the most modern locomotive transforms but about 8.1 per cent of the heat energy of fuel into work; the Diesel transforms 55 per cent, or over four times as much. Its fuel (crude oil, commonly called Diesel Oil) is not converted into gas as in gasoline engines, but is burned in the cylinder in the form of spray, and the expensive force of the products of combustion provides the motive power. Like the gas engine, however, it cannot start itself but must use some form of variable speed transmission to start trains; the best way so far devised consists of electric transmission, but the combined engine and generator plants have proven so heavy as to bar its use for heavy traction. Because of its high thermal efficiency, the Diesel engine offers opportunity to make great savings, and its future is very hopeful. A locomotive of this type now being built for Southern Pacific by Baldwin Locomotive Works seems to have overcome these handicaps and will soon be ready for trial.

The designs of an Italian Diesel locomotive show the following:

Weight in operation, approximately......	117 tons
Tractive effort at 18½ m.p.h............	19,840 pounds

The locomotive is started by highly compressed air stored in tanks and fed to cylinders at each end of the locomotive, which start it until sufficient speed is attained to start the Diesel engines; when the compressed air is cut off. The air tanks are recharged by means of a connection with the main engines.

The estimated fuel saving over a steam locomotive is 66 2/3 per cent.

This design shows progress in adapting the Diesel engines to locomotives of serviceable commercial sizes, particularly in solving the problem of weight, as the weight of a steam locomotive and tender to develop about 20,000 pounds tractive effort is 150 tons.

The hope of the railroad executive for conserving fuel lies in:

1. Substituting hydro-electric current for steam, as our best steam locomotives can now fully equal the efficiency of electric locomotives using current generated in steam power stations.

2. Substituting compound condensing engines for the simple engines now used. From progress made in Europe, the solution of this problem appears encouraging.

3. The discovery of a cheap, high-gravity fuel that can be used in some such engine as is used on automobiles and airplanes.

4. Reduction of the weights of Diesel engines sufficiently to permit of their use as locomotive engines and the development of a satisfactory variable speed transmission which will weigh very much less than an electric generator and motor.

A Diesel-electric locomotive built in Germany for the Russian government shows an overall efficiency between 21 per cent and 27.4 per cent. A steam locomotive tested at the same laboratory two days later averaged a total efficiency from 7.6 to 8.67 per cent. The fuel consumption of the Diesel electric locomotive was about one-third that of the steam locomotive.

In a special report published in 1923, the National Industrial Conference Board appointed a committee to determine among other things:

1. Do the industries of the United States need more or fewer engineers than the number now being graduated from engineering schools and colleges?

2. What kind of men do the industries require from the engineering schools and colleges, and what should be the nature of their education?

"The expansion of industry has been accompanied by vastly increased complexity of industrial operations, and the grouping of greater numbers of workers in corporate units has placed upon employers an increased social responsibility toward their employees and toward the life and affairs of the community. All of these changes have created problems of human, social and political relationships in which industry and society as a whole have become increasingly dependent upon trained technical and administrative leaders." Solutions to these problems have been sought by railroad executives in the establishment of pensions for superannuated and incapacitated workers; in hospital departments, to furnish hospital service on the payment of nominal fees; by the establishment of group life insurance plans whereby employees, regardless of age and without physical examination, receive the benefits of life insurance at approximately one-third the cost of the current commercial rates; and by the establishment of rest and reading rooms at terminals where no opportunities exist for relaxation after working hours.

"Of the 41,600,000 persons who were gainfully employed in 1920, according to the United States Census for that year, less than 4 per cent planned the activities and directed the energies of the whole working force." The same census figures show that since 1870 the number of administrators, supervisors and technical experts has rapidly increased. In 1870, the number of persons engaged in administration and supervision was 170,000, or 1¼ per cent of those gainfully occupied. In 1890, the corresponding data were 450,000, or 1.74 per cent; in 1920, 1,510,000, or 3.6 per cent.

An examination of the personal records of the Chairmen and Presidents of the railroads of the United States shows that in 1922, out of 32 Chairmen, 11, or 34 per cent, had risen from the Engineering Department, and out of 171 Presidents, 33, or 19 per cent, had risen from the ranks of engineers. Based as they are on data taken from the Census reports, the conclusions of the National Industrial Conference Board show increasing demands for the services of trained men, and furnish the most reliable and valuable information obtainable on the matters before us. As to schools, it says:

"It is the business of the schools to train young men into fertile and exact thinkers, guided by common sense, who have a thorough knowledge of natural laws and of the means for utilizing natural forces for the advantage of man and the advancement of civilization. In other words, it is the business of engineering schools to produce, not finished engineers, the goal being attained by the graduates only after years of development in the school of life."

Although a good technical expert may not develop into a good executive, nevertheless successful administrators should have certain characteristics, such as: A good grasp of the fundamentals of science, the ability to think logically and quantitatively, exactness of method and power of analysis, the habit of looking forward, sound economic theories, an unlimited capacity to learn, pronounced firmness combined with high sense of fairness and charity needed to control men, and the ability to write and speak clearly and correctly.

Discussion

Mr. F. B. Jewett, vice-president of the American Telephone & Telegraph Company and president of the Bell Telephone Laboratories, Inc., expresses these views:

"The industry which I am connected with is a highly technical one which is based on physics and chemistry and mathematics; but so are many of the big industries in our country and the more I see of them the more convinced do I become that the directors of these industries in the future are going to be drawn more and more from men who have a thorough grounding in the fundamentals on which the industries are based. In the old days it was not so, but each day we go on now, it becomes more clearly apparent that because the industries are technical, because they are based on the fundamental science, they must be guided by men who have a thorough appreciation of the fundamentals because business is hardly more than mixing the dollar or cents with physics and chemistry and mathematics. Since engineering schools are the place where we expect to turn out men who are going to guide technical industries, we should turn out men who know the principles of the fundamental sciences; who know the method of combining fundamental sciences with the dollar and cents proposition and know English in a way to enable them to express clearly what they know, so that others may profit by it, because it does none of us very much good to be ever so wise if we cannot express our ideas to others.

"It seems to me that if the engineering schools of the future are going to perform their function for the industries they have got to get closer to the proposition of teaching and really inculcating the fundamentals. Let the matter of trying to make executives go, if you will. The men of executive ability will come to the fore in the general run of things, I think, provided the Lord gave them the right human traits and provided they have a thorough grounding in the fundamentals."

Mr. E. M. Herr, president of the Westinghouse Electric and Manufacturing Company, says:

"I have been very much impressed with the discussion and especially by the points brought out by the last speaker. I heartily endorse his view of the importance of the fundamentals and of the idea of patient plodding in the minds of men who are going into industry. There is no royal road, to my mind, to a place of commanding importance in industry, or in any other business, and I do not believe that it is the function of educational institutions to try to teach young men to become captains of industry and administrators, or occupy very great and important executive positions."

"While there is general agreement on this view that one of the leading essentials in education in relation to industry is an adequate training in and knowledge of fundamentals, there is wide variation in the meaning of the term 'fundamentals.' From the point of view of the industrialist, the term 'fundamentals' means a general groundwork of useful knowledge but, more especially, a training in the power to use this knowledge in effective thought and action.

"The fundamentals of engineering training may be stated as follows:

(a) Mathematics;

(b) The important principles of physics, (mechanics, heat, light sound, electricity, magnetism) chemistry, biology and geology, the interrelations of natural phenomena and the application of these principles to practical problems;

(c) The principles of economics and their application to industry and commerce;

(d) The principles that govern the relations between people, not only as applied to managers and men, but also as applied to governments and society;

(e) The history of nations;

(f) The art of clear and correct expression in speaking, writing and drawing.

"The relative emphasis to be placed on each of these fundamentals is a matter to be determined for each engineering course."

In emphasizing the importance of training, we must studiously avoid withering the aspirations and stifling the ambition of the large numbers of men in railroad and industrial service who have not had the benefit of overmuch school or any college preparation. These men outnumber vastly the high school and college men, and to their credit be it said that the 65% of chairmen and 81% of presidents, remaining after taking account of those that have risen from the ranks of engineers, have been drawn largely from the men who have had none of the benefits of higher education. Without mentioning them the names of a number of the ablest and most distinguished railroad chairmen and presidents in the United States, who have by sheer ability and pluck risen from lowly ranks and have actually built their own careers and builded admirably well, suggest themselves.

"Sympathetic guidance of both the college man and the non-college man presupposes a careful evaluation of the work of all employees and assurance to them that talent and effective work will be known to and appreciated by the management. Educators report a growing feeling among undergraduates that in most large corporations a young employee often is lost in a department and for many months may not come under the observation of the leading men of the organization. A large public utility company, the two largest manufacturers of electrical apparatus and a few other large corporations which have unusual and enlightened personnel departments, in many cases are getting the pick of the young talent, because of their attention to this problem."

"These are some of the ways in which industry can supplement the work of the educators," and profiting by their example thus can we help those who are to "carry on" when we shall have passed.

Railway Motive Power Condition

Class I railroads on April 1 had 11,611 locomotives in need of repair, 18.1 per cent of the number on line, according to reports filed by the carriers with the Car Service Division of the American Railway Association.

This was a decrease of 388 under the number in need of repair on March 15, at which time there were 11,999, or 18.7 per cent.

Of the total number, 6,345, or 9.9 per cent, were in need of classified repair, a decrease compared with March 15 of 228, while 5,266, or 8.2 per cent, were in need of running repairs, a decrease of 160 during the same period.

Serviceable locomotives in storage on April 1 totaled 6,241, an increase of 823 compared with the number of such locomotives on March 15.

Class I railroads during the last half of March repaired and turned out of their shops 36,737 locomotives, an increase of 3,621 over the number repaired during the first half of the month.

Great Northern Grade Electrification

The Westinghouse Electric & Manufacturing Company has closed a contract with the Great Northern Railway Company for four electric locomotives and other equipment, to be used for the railroad's Cascade Mountain grade electrification, extending from Skymonish at sea level through the Cascade tunnel to the summit. This electrification, which will cost $1,000,000, will be undertaken immediately and is planned for completion within twelve months.

According to Mr. F. H. Shepard, Director of Heavy Traction of the Westinghouse Company, the electric locomotive will be an innovation in transportation. They will utilize direct current motors operated from a single phase, high voltage alternating current trolley, following the principle announced by Henry Ford for the electric locomotive he is now building for his railroad—the Detroit, Toledo & Ironton—using Westinghouse equipment.

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The New Era for Steam Locomotives

In commenting upon the symposium held at the New York Railroad Club in January on the above topic, attention was called to the optimism expressed by all of the speakers on the future possibilities of the steam locomotive. At the close of his contribution to the discussion, Mr. W. E. Woodard, the vice-president of the Lima Locomotive Works, said: "My vision of the locomotive of the near future is one with high boiler pressure, cylinders capable of developing from 3,000 to 3,500 horsepower, with a boiler and firebox which is capable of producing an adequate amount of steam for the cylinders in an economical manner. Such locomotives will have larger fireboxes that we have been accustomed to use. The coal will be burned at a low rate of combustion, giving high boiler efficiency. They will have a large gas area through the flues and tubes to match the firebox. They will have cylinders capable of producing these high horsepowers at relatively low rates of steam consumption. Such engines are not a dream; they will very soon be here."

This was spoken after the manner of a prophet and seemed prophetic to the greater portion of his audience. But he knew whereof he was speaking, for even then there was approaching completion in his own shops a locomotive that embodied all of the features of this seemingly prophetic utterance. Since then that embodiment has been put into service and has justified the eulogium of its sponsor. In another column there is published a description of some of the more important parts of this most interesting machine designed and built by the Lima Locomotive Works and which, despite its many novelties, contains nothing that common sense and the idea of the fitness of things would not justify. It, like some other locomotives of recent and novel designs, has swept away with a ruthless hand our preconceived notions of locomotive symmetry which should show straight smooth lines of boiler and cab, with no excressences after the manner of the English designs, but has even jumped to the extreme of some of the continental locomotives that have seemed freakish in the extreme simply because "He is only fantastical that is not in fashion."

But the anticipated big boiler required a big grate and this called for a four-wheeled trailer truck, for which there was no room, with the ordinary construction; so, forsooth, the rear extension to the frames is done away with and the truck treated as a separate vehicle. And why not? All of the buffing and pulling stresses of the locomotive have to be transmitted to the train through a separate vehicle known as a tender, and thence back in decreasing intensity to the rear of the train through a succession of separate vehicles. Then why not add one more, where it is desirable, between the locomotive frame and the tender?

Guessing is always a hazardous employment, but the guess seems reasonably safe that the stress put upon the rails by this four-wheeled truck will be markedly less than that put upon the rails by the trailing truck of a Pacific locomotive whose place it has taken, for it is well known that such a truck is not the easiest thing in the world upon a track.

The old eight-wheeled American type of locomotive was, and is, about the easiest locomotive vehicle on the track, closely followed by the ten-wheeler. The consolidation running forward is not as easy as the two preceding types, but it is not bad, for the unsymmetrical wheel base has been found to put far less destructive stresses on the track than the symmetrical. So here we have a consolidation wheel base pulling a series of vehicles, and acting really as a guiding truck for the leading one, which is the four-wheeled trailing truck. All of which means that the whole arrangement is exceedingly reasonable and we may well look to see it imitated in future designs, just as the trailer truck was found to be so invaluable an accompaniment to the wide firebox.

If what we know of the troubles with main crankpins during the early stages of the operation of new locomotives is any criterion to go by, that innovation in the form of a forked main rod and independent side rod to the rear drivers cannot fail to be a relief of the first water. To cut down the thrust on the main pin by 25 per cent is no small achievement in itself. Take this engine as an example. The cylinders are 28 in. in diameter and the steam pressure is 240 lbs. per sq. in. That means a thrust of the main rod of approximately 147,800 lbs., which, under ordinary construction must be carried by the main crankpin. To cut this tremendous load down by 36,950 lbs. is no mean feat. Small wonder that relieved of such a burden the pin behaved so seemingly and refrained from running hot.

Then comes the final crux of so enlarging the grate that low rates of combustion with the resultant saving in coal follow as a matter of course.

The limited cut-off, the relatively high steam pressure, the use of superheated steam in the auxiliaries, the two turrets for superheated and saturated steam, respectively, all make for economies that it does not seem possible can fail to be realized in service. And these results will be looked forward to with much interest.

Of course, such a locomotive with all of its innovations, and some of them quite radical, was not the result of a sudden inspiration, a creation *de novo*, as it were, but rather from long study and careful observation.

It is now about three years since the No. 8000 with its many novelties was put into service, with its marked economical success. From the very start its every action has been subjected to close and critical scrutiny. Every item of its construction has been studied analytically with the idea of improving it into something better. And step by step from the lessons taught by that successful machine this latest output of the Lima shops has been designed and it is a fairly safe prophecy to make that when this locomotive has emerged from the course of the same painstaking observations, that something better still will be evolved, and that the end is not yet.

Railway Management's Problem

In our issue for April we published the first installment of the very excellent paper which was read before the principal engineering societies of New York by Mr. Julius Kruttschnitt, entitled "The Engineer as an Executive." Elsewhere in this issue will be found the remaining portion of the paper which should be read by all who are interested in railway operating economies.

The author's treatment of fuel economy as sub-divided among the various devices or systems that contribute thereto, together with the announcement that the Baldwin Locomotive Works is building for his company a new locomotive in which the Diesel engine is employed as a prime mover, indicates the past and present field of economy has not only been covered, but that the future is being anticipated.

To those who have been for the past 30 or 40 years shouting that the salvation of our railways would be assured if they would all electrify their lines at once, regardless of the expense, there may be found an answer in the author's paper, and it is so plain, simple and businesslike, that any railroad man with just ordinary knowledge of engineering and operating conditions can see and understand it at a glance.

In the movement of improvement in locomotive design, we fully agree with the author that many devices which make for economy in operation were first used in other countries, yet we feel that the principal credit for our highly developed ultra-modern locomotive with its many economic accessories is due to American engineering genius, mechanical skill, and business energy.

With the fundamental essentials to a well balanced engineer-executive we are in full accord, holding, as we do, that engineering in its last analysis "consists of the application of nature's forces to the uses of man." He who can most successfully handle or apply these forces, is by that token the best engineer.

Mr. Kruttschnitt has announced his retirement as head of the Southern Pacific Company on May 31, leaving a record unequalled in railway construction and management.

The Saint Paul Receivership and the Government Guarantee to Railways

Verily, verily, some who come to Scoff should remain to Pray!

In our March issue we reviewed the report on the electrified divisions of the Chicago, Milwaukee & St. Paul Railway, pointing out that the greatest need of the property was not electrification, but a sufficient volume of business to justify their Pacific Coast extension, and a rearrangement of their financial structure on a basis whereby fixed charges would be insured with the possibility of a reasonably fair distribution to shareholders on their investment. As no railway could meet the above conditions, when circumstanced as the St. Paul was, it was not surprising to students of the situation to learn that the officers of this splendid property of about 11,030 miles, were forced to seek the protection of the courts.

Any business enterprise, in which the bonded indebtedness is practically twice the amount of capital or cash investment, is on a shaky financial foundation, and as a rule cannot eventually escape reorganization.

The two Pacific Coast lines with which the St. Paul comes into most direct competition are the Northern Pacific with a capitalization of $85,032 per mile of line, and the Great Northern with a capitalization of $66,526 per mile of line, while the St. Paul was only $60,558 per mile of line, but the latter's bonded indebtedness is about $450,000,000 of a total of about $668,000,000, or almost $2.00 of borrowed money for each $1.00 invested in the business. Therefore, with fixed charges out of proportion and with diminishing revenues, there was left only one avenue of escape: receivership and rearrangement of the company's financial structure.

Fallacious Doctrine of Government Guarantee to Railways

For the past four years, or since the passage of the Esch-Cummins law, politicians of varying degrees of ignorance and doubtful veracity, together with a motley horde of long haired advocates of destruction of all orderly business procedure, have been shouting from the housetops as it were of what they termed the grave injustice of guaranteeing to the railways a profit of 5¾ per cent and not giving other business and particularly the workmen a guarantee. As a matter of fact, the workmen, especially the railway employee, is by contractual agreement absolutely guaranteed a fixed rate of compensation or return per unit of service rendered and the railway is not guaranteed 5¾ per cent or any other amount of return on investment, and never was.

The only thing guaranteed by the Esch-Cummins law is that if any carrier is so situated as to be able to earn more than 6 per cent, the government at once takes one-half of it away from them, holding it in a pool or reserve fund for the benefit of the less fortunate lines.

More than 20,000 Miles of Railways in Receivership

At the close of 1923 there was in the hands of receivers the mileage indicated below that had not only failed to meet fixed charges, but had obviously nothing to distribute to the shareholders on their investment, and the majority of this mileage sought the protection of courts after the passage of the Esch-Cummins law which our demagogues, in complete disregard for the truth, tell the people insures the railways 5¾ per cent.

Mileage under receivership January 1, 1924	12,494
Value at $78,000 per mile................	$874,532,000
Amount earned on investment.............	———
Amount guaranteed by Government.......	———

Early in March of this year the St. Paul with its 11,030 miles of lines and estimated value of about $800,000,000, joined the other carriers already under the protecting wing of our Federal courts, thus making a total, at the present writing, of slightly more than 20,000 miles of railway, with an estimated value of about one and a half billion dollars ($1,500,000,000) that have failed to meet their fixed charges.

The foregoing would seem to be a full and complete refutation of the oft-repeated (but untruthful statement) that the Government favors the railways, by guaranteeing them a profit of 5¾ per cent on their investment.

It is quite clear to anyone of just ordinary intelligence, and with regard for the truth, that any railway which meets all its fixed charges from earnings, with even a small fraction of 5¾ per cent for either surplus or distribution to the owners, cannot be thrown into a receivership and it would therefore seem not inappropriate for some of our pseudo modern Sir Gallihad statesmen and their colleagues, who have so openly scoffed at the Esch-Cummins Act to make proper acknowledgment of their error and give evidence of a willingness to repair the injury resulting from a unwarranted and pernicious propaganda.

"Verily many who come to *scoff* should remain to *pray*."

W. E. S.

Biographical Sketch of John E. Wootten

By J. Snowden Bell

John Eastman Wootten was the son of John Castor Wootten of Virginia and Mary Copeland Wootten, his wife, of New York City, and was born in Philadelphia, Pa., December 23, 1822. After his education in private schools, he served an apprenticeship in the locomotive works of M. W. Baldwin in that city, in the course of which his mechanical ability and attention to duty gained for him the approval and favorable interest of Mr. Baldwin.

After completing his apprenticeship he entered the service of the Philadelphia & Reading Railroad Co., in the course of which he was successfully appointed engineer of machinery, February 1, 1866; assistant superintendent and engineer of machinery, February 2, 1871; general superintendent, January 15, 1873; and general manager, January 10, 1877. He resigned December 31, 1886, and died in Philadelphia, December 16, 1898.

The leading and characteristic feature of Mr. Wootten's career as a mechanical engineer was his design of the well-known Wootten locomotive boiler, in which for the first time a very large increase of area of grate surface was provided, in a firebox located above driving wheels of comparatively large diameter. This boiler was patented in the United States, July 3, 1877, No. 192,725, and the first one was applied on Engine No. 408 of the Philadelphia & Reading Railroad in the same year a similar engine, No. 412, was exhibited at the Paris Exposition of 1878, and afterwards tested on the Chemin de Fer du Nord of France, and Alta Italia Railway of Italy. These engines were of the 4-6-0 type, weighing 86,150 lbs., with 67,900 lbs. on driving wheels; cylinders 18 x 24; driving wheels 54 inches; firebox 8 ft. 6 in. wide by 7 ft. 6 in. long, inside, giving a grate area of 64 sq. ft., which has been very much succeeded in later constructions.

About 800 Wootten boilers were in service at the close of 1895 and there are probably now between 3,000 and 4,000, of the exact Wootten boiler type, and many others embodying its leading features.

The Wootten locomotive boiler was the subject of award of the following medals, viz.:

John Scott medal (bronze), awarded by the City of Philadelphia, 1891, on the recommendation of the Franklin Institute, to John E. Wootten, "for his invention in locomotive boilers."

Exposition Universalle de 1878, Paris (silver), to Philadelphia & Reading Railroad Co.

National Exposition of Railway Appliances, Chicago, 1883, to Philadelphia & Reading Railroad Co., "for best locomotive meeting important new principles."

Early Baltimore & Ohio Motive Power

Editor Railway & Locomotive Engineering:

I have read with a great deal of interest the article on The Modernization of the Baltimore & Ohio Railroad Motive Power in your April issue by Mr. J. Snowden Bell and would ask permission to supplement it with some personal recollections:

My father worked for the Baltimore & Ohio in the old Camel engine days and I have often heard him discuss them. He used to say that while they were an economical engine on upkeep, they were anything else but economical on human life. Running along, one of those "infernal" cast iron tires would fly all to pieces. The Camel would plunge down the bank, turn end for end, and then roll over and kill the engineer. A solid chill tread driver would have been much safer.

They were weak in the throat sheet, and given to explode, and kill everything in sight. A big cab away up on top of the boiler lessened the engineer's chances of escape in case of trouble. That and the big dome and general unbalance rendered them top heavy, and likely to bounce off the track at any considerable speed.

More than one engineer was hurt in trying to make her "hook" in an attempt to reverse by manipulating the starting bars.

Ross Winans, like more than one other great man, was sot in his ways, even to a disregard of all advice, and that, too, in things non-essential, as well as those of importance. He would paint his engines a dingy bottle green, and you could not pay him to paint them any other color. He would not lag or jacket his locomotive boilers, no, sir! If you want a different color paint, or a lagged boiler, do it yourself, not he! "The laws of the Medes and Persians altereth not."

His contention with Mr. Tyson brings out the same stubborn characteristics in his nature. He could not cooperate with anyone.

I have in my possession two stereoscopic views, one of a Camel engine standing in the yards at Piedmont, W. Va., and the other of a ten wheeler (a Perkins, I think it is) either at Piedmont or Martinsburg.

William B. Rainsford.

364,153 Commute to New York City

The railroads serving New York City carry more commuters into the city every weekday morning, and home every evening, that there are people in the whole state of Arizona. The average number of commuters coming into New York daily is 364,153, according to the New York City Transit Commission.

In addition to the commuters, there come into the city on the railroads an average of 130,650 visitors a day. Some of the commuters and visitors reach New York City by way of the ferry, but most of the ferry traffic is in conection with train service.

The total passengers carried to and from New York on the railroads in 1923 and 1924 was as follows on the respective lines:

	1923	1924
Baltimore & Ohio	620,000	550,000
Central of N. J.	15,752,834	15,776,662
Del., Lackawanna & West.	22,201,447	22,359,818
Erie	30,889,917	32,043,150
Lehigh Valley	743,502	755,676
Long Island	69,766,867	75,000,887
New Haven	17,666,194	18,339,242
New York Central	30,025,529	31,717,518
N. Y., Ontario & Western	551,753	544,365
N. Y., Westchester & Boston	5,796,093	6,045,424
Pennsylvania	39,741,298	40,456,529
Totals	233,755,434	243,589,271

The Energy Supply for the Chilean State Railway Electrification

By David C. Hershberger, General Engineer, Westinghouse Electric & Manufacturing Company

The first zone of the Chilean State Railway broad gauge lines, with 116 route miles of main line and 28 miles of branch lines, comprising a total of 233 single track miles, is now in operation. All of the power for this electrification is furnished by hydro electric development and additional sites are available near the second, third and fourth zones so that the extension of railroad electrification and water power development should go hand in hand.

The most recent hydro-electric development is that of the Compania Chilena de Electricidad, Limitada in the erection of their Maitenes plant located approximately 37 miles southeast of Santiago. This plant is located on the Colorado River which originates near Mt. Tupungato with an elevation of 22,500 feet. The possibilities of water power development in this district by three plants on the Colorado River alone, are estimated to be at least 50,000 hp. and for the adjacent district an additional 80,000 hp.

Water Carried Through Tunnels

A special intake is used for diverting the water of the Colorado River in such a way as to eliminate the rock and gravel which is carried down due to rapid flow. The intake is of masonry construction provided with gates for flushing out rock and gravel and for controlling the amount of water diverted to the canal.

The water is carried from the intake along the side of the mountain through a series of open canals, covered canals, and tunnels. Much of this construction was very difficult as the tunneling along the side of the mountain was through solid rock. In the sections where covered canals were necessary for protection against mountain slides and earth falling due to erosion, considerable concrete work was required. Settling beds are provided for settling out sand and silt.

Steel penstocks carry the water from the forebay down to the generating station through a head of 580 feet. A separate penstock was constructed for supplying each turbine, so that the failure of the penstocks would not put the entire plant out of commission.

Generating Stations

The Maitenes station located at an elevation of 3728 feet above sea level contains three 8125 Kv-a., 6600 volt, 3-phase, 50 cycle, 600 r.p.m. water wheel type generators designed and built by the Westinghouse Electric Manufacturing Company. The normal capacity of 8125 Kv.-a. is obtained at 80 per cent power factor when operating continuously at this load. Each generator has a direct connected exciter of 60 Kw. capacity at 125 volts for excitation of the field. The exciters are shunt wound and each has a capacity of 10 per cent in excess of that required to excite its generator under the worst conditions of load and power factor.

Each generator is equipped with thermo couples for measurement of hot spot temperatures. The reactance of these generators is such that if the machine is subjected to a short circuit the current will be limited to approximately twelve times full load current, instantaneous values.

The generators are driven by Pelton waterwheels of the horizontal overhung single discharge turbine type, operating at a head of 580 feet.

The Maitenes station is designed to tie-in with other stations in the system which were constructed a number of years ago and which are 50-cycle stations. It is for this reason that the Maitenes station was made 50 cycles. There are several other systems in Chile which are 60 cycles systems and which are used for supplying power to mining operations but are of an isolated character, so that at the present time there is no real need for considering their inclusion in a super-power system.

The voltage of the generating station will be stepped

General View of Maitenes Generating Station Under Construction Showing Steel Penstocks

up from 6600 to 110,000 by 3 6000 Kv.a. single-phase, oil-insulated, water-cooled transformers of the outdoor type. All breakers and high tension switches for the 110,000-volt switching will be of the outdoor type. The panel board and metering equipment are located on a balcony within the generating station building.

The Florida station, with a capacity of approximately 15,000 Kw. has been in operation a number of years. This is a hydro-electric station supplying power to the city of Santiago, but now forms one of the hydro-electric generating stations of the system of the Compania Chilena de Electricidad, Limitada. This station may, at times, feed some power through to the State Railways electrification, but only in cases of emergency, as the requirements of the city of Santiago are more than enough to take up the full capacity generated in this station.

The power supply for Santiago and for the railroad electrification is augmented by a steam station known as the Mapocho station which is located in the city of Santiago. This station has a capacity of approximately 20,000 Kw. and serves as a standby station for use in emergency in case of failure of either the Maitenes or Florida hydro-electric stations. This station was also used to supply peak load in excess of the Florida station capacity previous to the construction of the Maitenes plant.

The San Cristobal receiving station is located at Santiago and serves as a switching and step down station stepping down from 110,000 volts to 12,000 volts for power supply for the city of Santiago, and for the supply of the railway substation at Quilicura, known as Substation No. 5, of the Chilean State Railways. The receiving station contains four 7,500 Kv.-a., 3-phase, 60-cycle, oil-insulated, force-cooled transformers for stepping down from 110,000 volts to 12,000 volts. In case of failure of the Maitenes generating station, power from Florida hydro-electric and Mapocho steam station would be stepped up from 12,000 volts to 110,000 volts for supplying the first zone of the State Railways electrification.

Transformer Stations

The Last Vegas station contains three 7,500 Kv.a., 3-phase, 50-cycle, oil-insulated, force-cooled Westinghouse transformers. These step down from 110,000 volts to 44,000 volts for supplying the Chilean State Railway substation No. 3 at Llai Llai, Substation No. 4 at Rungue, and Substation No. 2 at San Pedro.

This station also supplies power for lighting industrial and agricultural purposes in the Los Andes district, and for the towns along the railroad as far as Quillota. The transformers and switching equipment are arranged for outdoor mounting and are equipped with switchboard temperature indicators, as well as dial type thermometers with alarm contacts.

The line sectionalizing and transformers are controlled by Westinghouse time "G-11", 5-pole, single-throw, outdoor type oil-circuit breakers. Eight breakers control the 110,000-volt line, while 12 breakers control the 44,000-volt line.

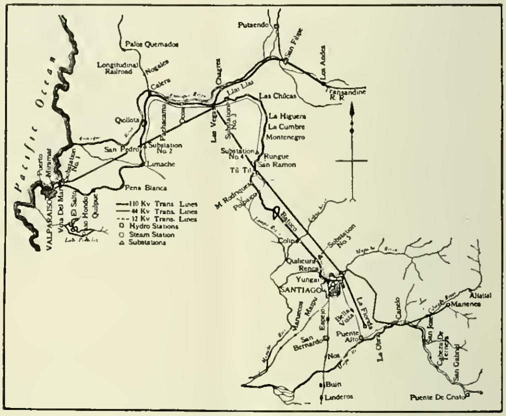
The Miraflores substation is designed to step down from 110,000 volts to 12,000 volts for power supply to the city of Valparaiso and railway substation No. 1 at Vina del Mar. This station contains four 7,500-Kv.a., 3-phase, 50-cycle, oil-insulated, force-cooled transformers, and six 3-pole, single-throw circuit breakers. Outdoor type transformers and circuit breakers are used.

The Transmission Line

For the 37 mile line between the Maitenes generating station and the San Cristobal receiving station, a 2-circuit line of No. 2/0 copper transmits the power at 110,000 volts, 3-phase, 60 cycles. Between San Cristobal receiving station and Limache, a distance of 67 miles, power is carried at the same voltage by a two-circuit transmission line of No. 3/0 aluminum conductor steel reinforced. Between Las Vegas and the railway substations at Llai Llai and Rungue which are fed from this step down station, a two-circuit 44,000-volt transmission line uses No. 2/0 aluminum conductor steel reinforced. From Las Vegas to Los Andes for industrial and lighting supply No. 2/0 aluminum conductor cable is used. From Limache to Miraflores, a distance of 22 miles, twin-circuit No. 1/0 copper conductor is used. The 110,000-volt transmission line carries a 5/16 in. high strength steel ground wire. On the section where aluminum conductor is used the normal span length of 984 feet, while the maximum span is 2000 feet. The normal horizontal spacing of conductors is 17 ft., 6 in., while the vertical spacing is 9 ft., 6 in. The middle wires are offset 3 ft. horizontally in order to avoid having conductors come in contact in case a load of snow or sleet should drop from one of the lower wires causing it to swing back against the conductor above.

The twin-circuit transmission lines for the 110,000-volt system, are carried in steel towers of sufficient height that the lowest arm is 46 ft., 3 in. from the ground.

The transmission line carrying 110,000-volt power



Map of First Zone of Chilean State Railway Showing Railroad and Power Stations

takes a course westward from the receiving station at Santiago, crossing the railroad near Til Til, continuing in the same direction as Las Vegas from which point it takes a southwesterly direction to the Miraflores step down station. The total length of the line between San Cristobal receiving station and Miraflores step down station is approximately 88 miles.

The Chilean Government preferred to purchase power from a reliable Power Company rather than to undertake to construct generating stations and transmission lines to supply the railroad electrification. The State Railways own the railway substations of the First Zone while the Compania Chilena de Electricidad, Limitada owns all of the transmission lines. Power is measured on the low tension side of the transformers supplying the 2,000 Kw. motor generator sets in the substations. A nominal amount is added to the energy readings to make up for transformer losses.

New York Railroad Club Meeting

The meeting of the New York Railroad Club on Friday, May 15th, will be the last one of the present season and will incorporate some rather unusual features. The place of the meeting has been changed from the Engineering Societies building to the main ballroom of the Biltmore Hotel. R. E. Woodruff, superintendent of the Erie at Buffalo, N. Y., will address the club on "Lubricating a Railroad Organization."

The Car Service Department Glee Club of the Pennsylvania Railroad at Philadelphia will sing. This club has an enviable reputation and has only recently completed a week's engagement at one of the prominent theatres in Philadelphia. Part or all of the glee club program will be broadcast.

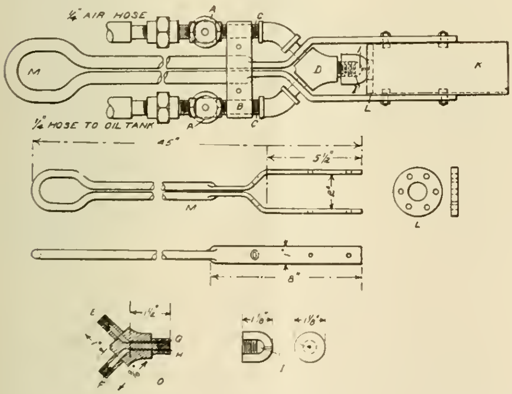
Shop Kinks

Some of the Handy Shop Tools in Use on the Erie Railroad

A Portable Oil Burner

It is frequently desirable to have a heating flame that can be moved from place to place and this is especially true in the execution of light repairs on steel cars as in the straightening of bent plates in place. The burner here illustrated meets these requirements in that it only requires a hose attachment to the air pipes and an oil tank which may itself be portable.

Two ¼ in. hose lead to the air supply and oil tank, respectively, from the burner. They connect to ¼ in. pipes in which there are the two globe valves *A*. The piping, which consists of a union, a globe valve and three nipples, is light and short, and the two lengths are held together by the clamp *B*, which is made of 1 in. by ⅛ in. steel. The long nipples at *C* are screwed into two 45 deg. elbows that are connected by short nipples to the atomizer *D*, which is shown in section in the detail. This detail is cast solid and the holes are afterwards drilled. The air enters at *E* through a regular ¼ in. pipe connection and the oil at *F* by way of the ¼ in. piping, but the entering hole in the casting is drilled to a diameter of 3/16 in. These two holes run down to the body of the casting where they meet the two holes *G* and *H*. The hole *G* for the air is drilled to a diameter of 1/16 in. and the hole *H* for the oil is but 1/32 in. in diameter. The atomizer is completed by the cap *I* which is machined from stick brass and is shown in section and end elevation by the detail.

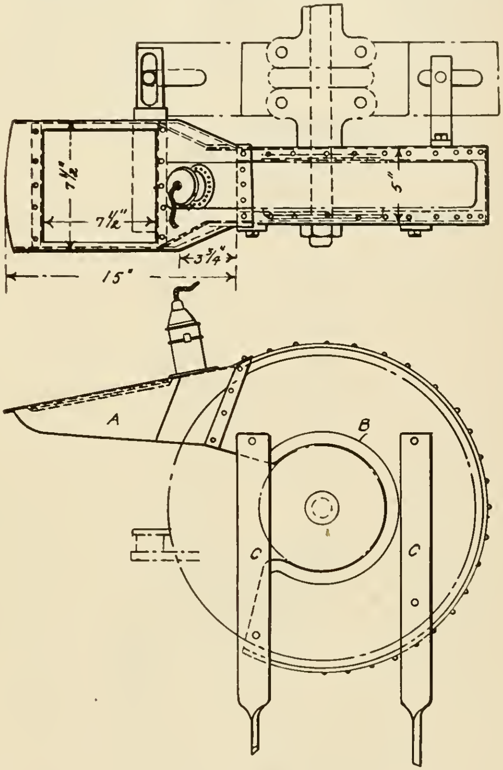


Details of Portable Oil Burner

This cap is screwed on to the body of the atomizer and leaves a dome-shaped cavity at *I* between the discharge face of the atomizer body for the oil and air and the exit hole in the cap. This latter hole is 1/16 in. in diameter. The oil and air, which are discharged into the dome of the cap are there thoroughly mixed and issue from the hole in the cap in a condition to be readily ignited and burned.

They enter a tube *K*, which is made of a piece of 2 in. flue 6½ in. long. This tube is partially closed at the entering end by a disc *L* which is electrically welded to the interior of the tube and, in addition to the central hole ¾ in. in diameter against which the cap of the atomizer abuts, it has six holes of 3/16 in. diameter drilled through it for the admission of air.

The burner is provided with a handle *M* made of ½ in. round iron, bent to form a loop and flattened at the ends where it is attached to the tube by four bolts 3/16 in. in diameter, as shown in the engraving of the assembly. This handle has a total length of 45 in. and extends back of the clamp *B* for a distance of about 37 in., thus giving the operator opportunity to hold and manipulate the burner with both hands; which can be readily done as the whole is very light.



Guard for Grinding Wheels

A Guard for a Grinding Wheel

The laws of a number of states are now very explicit as to the character of the safeguards that are to be placed about machines in motion, in order to protect workmen from injury, and among them is that requiring a shield to be placed over emery wheels to arrest the flight of the parts of a wheel that may burst.

The shield here illustrated is made of sheet metal and fits closely over the wheel with a projecting hood at *A* through the top of which an electric light is inserted. This hood is about 2 in. wider than the main part of the guard and is fitted with a sheet of glass 7½ in. square through which the workman can see the work that he is grinding.

At the center where the guard encircles the shaft, it is stiffened by a strip of half-inch round iron, as shown at *B*.

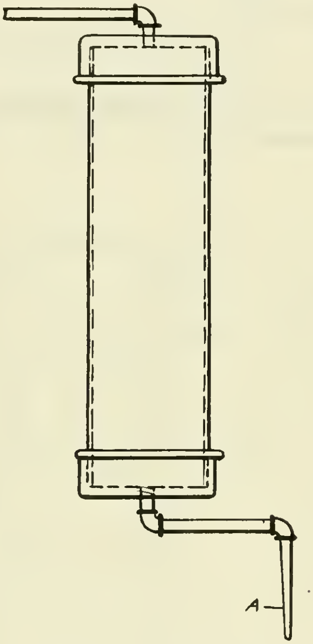
The guard is carried on two uprights *C* that may be bolted to the machine frame or to the floor.

Grease Container for Air Motors

The small amount of grease used at a time on air motors makes for some waste and more untidiness where the supply is kept in a can and is taken therefrom with a wooden spud.

The simple device here shown makes it possible to draw any amount of grease, that may be required, from the container and do it neatly and efficiently.

It consists of a piece of 6 in. pipe 24 in. long, on each



Grease Container for Air Motors

end of which an ordinary 6 in. pipe cap is screwed. A ¼ in. pipe from the shop air line is screwed into the upper cap and leading on from the one at the bottom there is another ¼ in. short length of piping, having a couple of elbows for the convenience of location of the discharge end, terminates in a flattened nipple at *A*. A globe valve placed in the air pipe completes the outfit.

In order to use the device, the upper cap is removed and the 6 in. length of pipe is filled with grease and the cap then replaced. With a pipe of the dimensions given the cubic contents are a little more than 675 cu. in. or a little less than three gallons. An ample supply to last for some time at the ordinary rate of use.

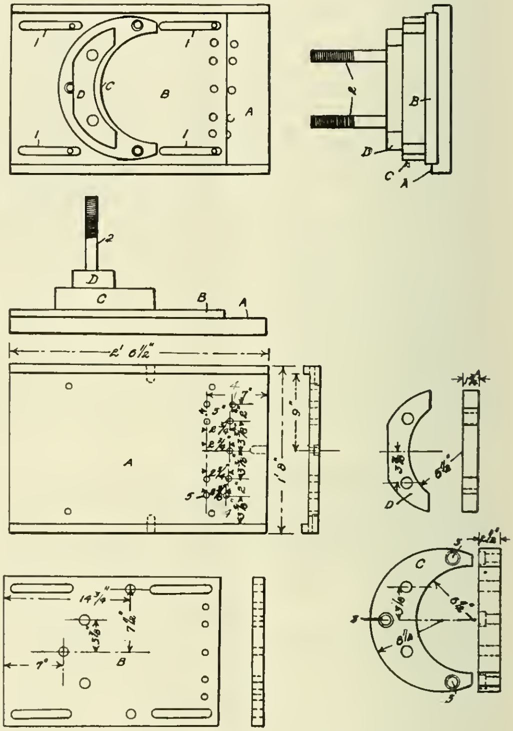
In order to draw the grease from this container, the air pressure is admitted at the top, and this forces the grease down and out through the outlet pipe at the bottom whence it issues as a continuous ribbon.

The only precaution to be taken is that, in filling the container, the grease shall be pressed down so that the whole sectional area shall be filled. For it is evident that if the grease were to be thrown in in lumps, the compressed air would simply flow down through the interstices between them and escape at the bottom without forcing the grease on ahead of it.

Chuck for Boring and Turning Eccentrics

This chuck, as the title implies is intended for holding an eccentric at one setting for both boring and turning.

It has a base *A* which is a trough-shaped casting 2 ft.



Chuck for Turning and Boring Eccentrics

6½ in. long and 20 in. wide which is bolted to the table of the boring mill on which the work is to be done.

Sliding in this trough is a carriage *B* that is bolted to the base by studs coming up through the slots 1, so that there is a considerable range of adjustment possible as these slots are 7½ in. long. The studs are ⅞ in. in diameter. Screwed into this carriage are two 1¼ in. diameter studs 2, over which the support *C* and the strap *D* is slipped. The support *C* is fastened rigidly to the carriage by three tap bolts passing down through the holes 3 and into countersinks of the same.

The body of the eccentric rests upon this support, and is clamped in place by the strap *D* by means of nuts on the two studs 2.

Referring to the details it will be seen that in the base there are two rows of holes near the right hand end, marked 4 and 5. The row of holes marked 5 extend across in a line at right angles to the center line, while the corresponding holes in the line 4 are set at different distances from the mating holes in the line 5.

There is a corresponding row of holes in the carriage *B*. All of these holes are of a nominal diameter of ⅝ in. and are tapered so that a pin may be put down through a hole in the carriage and find its mate in the base.

When attaching the chuck to the machine the carriage is adjusted so that, with a pin passing through one of the holes in the carriage and another in the line 5 of the base the inner face of the support *C* is concentric with the center of the table. The nuts on the studs passing up through the slots in the cariage are then tightened, and the eccentric placed in position for boring with the center line of its eccentricity in line with the center line of the chuck.

After it has been bored, the nuts on the studs passing through the slots in the carriage are released, and the tapered adjusting pin attaching the carriage to the base removed. This sets the carriage quite free from the base so that it can be moved.

It will be noticed that the spacing of the holes in the line 4 from their corresponding holes in the line 5, is 2⅜ in., 2½ in., 2¾ in. and 3 in. Thus, after boring the eccentric it can be moved out of center by any one of these four distances, and the pin attaching the carriage to the base inserted and a corresponding eccentric throw of 4¾ in., 5 in., 5½ in. and 6 in. be obtained when it is turned accordingly. The carriage being rigidly attached to the base at all times, when a cut is being taken by tightening the nuts on the studs that pass through the slotted holes 1.

Approve Rail Plan in Event of War

Tentative plans for operating the railroads in time of war were approved at the regular spring meeting of the Association of Railway Executives held on April 18 at the Blackstone Hotel in Chicago, with most of the Class I roads represented. R. H. Aishton, chairman of the Executive Committee of the association, presided.

Under the tentative plan the Government will not take over the railroads in time of war unless the emergency is such that the railroads need the backing of the government to insure continuous and efficient operation and unless, in the opinion of the President, such a step is necessary as a matter of national safety. In working out the plan the War Department has endeavored to take advantage of the experience gained during the World War. This plan has also been worked out in conjunction with other plans relative to the procurement of war supplies in time of war.

Secretary of War to Have Control

The plan provides for the exercise of the power of the President to take possession and assume control of the transportation systems as provided by the Army Appropriation Act of August 29, 1916 (the same provision under which the President assumed control of the railroads during the World War), but control of the transportation systems would be exercised by the Secretary of War, who would select an executive assistant to direct operations and be responsible for the execution of such policies as are outlined by and with the approval, or by the authority of, the Secretary of War. The Secretary of War would also be assisted by a committee of railway presidents known as the Executive Committee, the members of which would be nominated by the Association of Railway Executives and approved by the Secretary of War.

It would be the fixed policy of the Committee to exercise its functions through individual companies as corporate organizations and not to interfere with any company in matters of management, operation or domestic arrangements except when such interference may be necessary.

Individual Managements to Remain

In order to avoid demoralization, so far as possible, of the working forces and of the management of the individual lines, and to obtain the advantages of the experienced and organized personnel on the several lines, the actual operation and control of the individual railroads would be left, under the plan, in the hands of the Executive Staff and organization, subject to the control and direction of the Executive Assistant.

The plan also provides the basis for computing the compensation to be paid carriers while under federal control.

Pennsylvania Officers to Study Transportation Problems

In the interest of advancing the science of railroad transportation a number of investigations and studies will be made this spring and summer by officers of the Pennsylvania Railroad System with respect particularly to Pennsylvania conditions. Reports of their findings will be presented next November at the annual meeting of the Association of Transportation Officers of the System, the object of which is to develop and to put into practice the best methods of railroad operation.

The subjects assigned for this year cover a wide range of investigation in many departments of transportation service. For instance, consideration will be given to the question of whether economies can be effected in freight train operation by reducing the tonnage of trains in order to quicken the movement of freight between terminals and to reduce the time in yards accumulating freight for heavy tonnage trains.

Studies will be made to determine what can be done to stabilize the forces engaged in making repairs to locomotives and cars and the advantages to be derived from such stabilization; what economies can be effected through remote control of switches at outlying sidings and other tracks. A special report has been called for dealing with the relative cost of maintaining track on stone, gravel and cinder ballast and another special report on the effect of automatic signals on single track operation.

The Committee on Railway Economics of the Association will make a study and report of the proper measure of operating efficiency. The same committee has also been assigned to determine whether it would be worth while to adopt a general policy of storing coal for company use at selected locations during summer months to provide partially against winter consumption.

Consideration also will be given to the question of establishing special apprentice positions which will cover in one course all of the operating departments of the railroad.

Canada's Experience

After three years' operation under government ownership of railroads, Canada is in a peculiar plight:

Business of the roads has increased 3.9 per cent.

Number of employees has increased 60.3 per cent.

Service per employee has decreasd 35.1 per cent.

Efficiency by ton and passenger mile test has declined 43.3 per cent.

One hundred millions of dollars loss annually must be met by increased taxation.—*The Great Western Magazine.*

Snap Shots—By the Wanderer

Some months ago I commented on the ethics of a manufacturer invading the domain of another man's specialty and especially if that other man had taken a crude, undeveloped idea, made it into a practical mechanism and created a market for it. At the same time I suggested that it might be inadvisable to do business with such a man, because of his lack of experience in the making of the article in question, and that the know-how of the original adapter might be well worth paying for.

There is still another point that is worthy of consideration, by the intruder himself, and that is his own possible inability to make as cheaply as he can buy. An interesting example of this was thrust upon me some time ago. A certain manufacturer used large quantities of pipe and fittings and, without making any analysis or attempting to ascertain the facts, he decided that he could make all fittings of 3 in. and over cheaper than he could buy them of the regular specialty manufacturer. And this he proceeded to do, and kept it up for years, selling at the scheduled prices of the regular maker, and keeping no detailed cost accounts of his own.

Then he engaged a young man as superintendent who wanted to know some things heretofore unknown in that establishment, and among others, the cost of those home-made fittings. The result was harrowing. He found that, for years, the concern had been making a fitting at a cost of a dollar and a quarter and selling it for forty cents, literally by the thousands. The manufacturing was abruptly stopped but the old owner never forgave this youngster for unearthing this unwelcome fact.

Such a performance as this is paralleled by the foolishness of a man not versed in the art attempting to invest off-hand something to fill a long-felt want and evade, at the same time, the patents of others who have been working and experimenting along the same line for years.

To point my moral with an instance from life, I recollect a certain engine builder of the old school, when the production of motion was of more moment than the saving of the steam used to produce the motion, who had had a fairly successful career in the building of ordinary common heavy slide-valve engines, and who was suddenly seized with the conviction that a balanced valve would add greatly to the value of his output.

Now it so happened that this man was a patient fiend; one of those creatures who believe that everybody's patent, except his own, was intended to be infringed or evaded. So, though his assistant recommended a standard balanced valve of tried and approved merits for his consideration, he would have none of it, and scouted all previous works and immediately proceeded to invent a valve that would "avoid" all other patents. Of course, he had it patented. It was done in such an easy, off-hand, happy-go-lucky way as to be quite charming in its naivete. At first the new valve balance worked only too well, for it stuck and bent the valve stem, and when it was finally adjusted so as to move with freedom, the valve was no longer balanced. I think the little experiment cost upwards of a thousand dollars, but it "avoided" all patents. But, then, no one cared whether it did or not as it was useless and of no account.

No, nine times out of ten, you can't do it, so save your money, time and temper and come right up to the scratch and pay a decent royalty for what you want to use and don't imagine that you are so much smarter than all the rest of creation that you can reach, at one bound, the heights attained by others through years of slow and laborious climbing.

Speaking of patents there is a saying accredited to Mr. Edison that, like many other things that he has said, is the embodiment of good, sound sense. It is to the effect that it takes one hundred times the ability to develop an invention that it does to conceive of it. Our laws have thrown the doors of patent protection so wide open that every amateur in every art has rushed in until the office and its records are filled with a heterogeneous mass of matter that is of no earthly use except to stand as a stumbling block in the way of future inventions.

If there were only some way to stop the flow of useless matter it would be an improvement, yet that very ease in procuring protection has contributed more than any other one thing to the industrial efficiency that we enjoy. Still when I review the years of effort and disappointment that falls to the lot of so many inventors, I sometimes feel like congratulating one on his common sense who, after devising some labor saving device, for his own use, stops right there. And there are many who do just that thing and our country machine shops are filled with patentable articles that are handy devices. Devices like the railroad shop kinks that are published in another column, the cost of whose exploitation would probably be more than any possible profits that could be derived from them.

Possibly the excess in patent applications would be checked, if our government would make the same announcement as does that of France. Every French patent bears the notice "Patented, without any guarantee on the part of the government." That is to say, we give you a patent and the protection going with it, but do not guarantee the validity of what we have granted you. The United States does identically the same thing, except that it makes no announcement of the fact. The result is that the great majority of inventors think that once they have obtained their letters patent they have an assured protection, whereas, as a matter of fact, they have merely secured the right to sue a trespasser; and it is only after expensive litigation that they can be assured of the rights which they fondly thought were their's at the start.

Many patents are applied for honestly in the belief in the absolute novelty of the device and a patent is granted whose claims are broad enough to cover the whole art. Yet when read in the light of the prior art will be found to be so limited in their scope as to just cover the actual construction revealed in the specifications, and to quite fail to keep out innovators or even copyists who steer clear of the device shown in the drawings.

In a patent suit the text of the defense is usually the ninth and tenth verses of the first chapter of Ecclesiastes: "There is no new thing under the sun. Is there anything, whereof it may be said, See, this is new? It hath been already of old time, which was before us." And this old thing is only too often some device that could never be reduced to practical working, but there it stands, as I said before; a very substantial stumbling block in the way of the man who has made a workable improvement. That it is bad, "it is true:

'Tis true 'tis pity; And pity 'tis 'tis true."

Pennsylvania Apprentice School Enlarges Its Scope

With the completion of new and enlarged facilities, the scope of the Pennsylvania Railroad Apprentice School at Altoona, Pa., has been materially increased, so that approximately 400 apprentices are at present receiving the benefit of its courses of instruction.

The school, which was temporarily discontinued in 1921, was reopened in January of the present year, but was confined to apprentices from the Altoona Machine Shop only. More room has since been provided by an extension of the building, which has just been finished, and in addition to the machine shop boys, the school is now open to regular apprentices from the Juniata shop, the Altoona car shop, the South Altoona foundry, and the Middle Division of the railroad.

School sessions are held after working hours from 7.00 to 8.30, and 8.30 to 10.00 p. m. on Monday, Tuesday and Wednesday, and from 4.30 to 6.00, 7.00 to 8.30, and 8.30 to 10.00 p. m. on Thursday and Friday, the boys being arranged in sections so that each boy will be given three hours' school work each week during the period of his apprenticeship.

The curriculum provides for mechanical drawing, mathematics and mechanics bearing on shop work, study of materials of construction which deal with the manufacture of iron and steel and characteristics of different kinds of steel as used in the shop. The courses are adapted for the apprentices in the trades of the different crafts, such as machinists, boilermakers, pipe fitters, and electricians.

The apprenticeship course is for the purpose of developing by shop training competent and skilled mechanics in the various trades, and by supplementing this with school training to qualify the apprentices for future positions as inspectors, gang foremen, assistant foremen, foremen and other supervisory positions.

Notes on Domestic Railroads

Locomotives

The Fairport, Painesville & Eastern Railroad has placed an order for 1 switching locomotive with the Baldwin Locomotive Works.

The Bear Creek Logging Company has ordered 1 Mikado type locomotive from the Baldwin Locomotive Works.

The Kansas City Mexico & Orient Railway plans the purchase of 4 oil burning locomotives in connection with the reorganization.

The Reading Company has ordered 5, 0-8-0 type switchers from the Baldwin Locomotive Works.

The Chile Exploration Company has placed an order with the Baldwin Locomotive Works for 12 Mikado type locomotives.

The Seaboard Air Line has placed an order with the American Locomotive Company for 20 Mikado type locomotives.

The Havana Central Railroad of Cuba is inquiring for 6 Mountain type locomotives for use on the United Railway of Havana.

E. Atkins Company of Cuba, is inquiring for 3 Consolidation type locomotives.

The Seaboard Air Line Railway has placed orders with the Baldwin Locomotive Works for 10 Mikado and 10 Mountain type locomotives.

The Lietchfield & Madison Railroad has placed an order with the American Locomotive Company for one switching locomotive.

The New York Central Railroad is inquiring for 26 locomotive tenders of 15,000 gal. capacity.

The New York, Chicago & St. Louis Railroad is inquiring for 10 eight-wheel switchers.

The Maryland & Pennsylvania Railroad is inquiring for 1 Consolidation type locomotive.

The Great Northern Railway plans the purchase of 4 electric locomotives in connection with its electrification over the Cascade Mountains.

The Denver & Rio Grande Western Railroad has placed an order for 10 Mikado type locomotives with the Baldwin Locomotive Works.

The Minneapolis & St. Louis Railway is inquiring for 20 Mikado type locomotives.

The Detroit & Toledo Shore Line has placed an order with the American Locomotive Company for 2 switching locomotives and 1 Mikado type locomotive.

The Florida East Coast Railway has ordered 15 Mikado type locomotives, and 6, 0-8-0 type switching locomotives from the American Locomotive Company.

Passenger Cars

The New Orleans, Great Northern Railroad has placed an order for 1 combination passenger and baggage gasoline motor car with the J. G. Brill Company.

The Missouri Pacific Railroad has placed an order for 2 combination passenger and baggage gasoline motor cars with the J. G. Brill Company.

The Southern Pacific Company has ordered 27 passenger cars, as follows: 10 coaches from the Pullman Car & Mfg. Company; 5 baggage cars from the Bethlehem Steel Company; 6 baggage-postal cars, from the Standard Steel Car Company; 6 baggage horse cars, 70 ft. in length from the American Car & Foundry Company.

The Pennsylvania Railroad has placed an order for 1 passenger and baggage gasoline motor car with the J. G. Brill Company.

The Richmond, Fredericksburg & Potomac Railroad is inquiring for 4 express and 1 postal car.

The Canadian National Railways have placed an order for 1 combination passenger and baggage gasoline motor car with the J. G. Brill Company.

The Virginia, Carolina & Southwestern Railroad has placed an order with the Edward Railway Motor Car Company for 1 gasoline motor and 1 trailer.

The Pittsburgh Railways have placed an order with the Standard Steel Car Company for 100 street cars.

The Florida East Coast Railway is inquiring for 15 baggage cars.

The Baltimore & Ohio Railroad has placed an order for 20 additional passenger cars for use on the Staten Island Railroad with the Standard Steel Car Company.

The Baltimore & Ohio Railroad has placed an order for 2 combination passenger and baggage gasoline rail motor cars with the J. G. Brill Company.

The Canadian National Railways are inquiring for 5 two-compartment observation sleeping cars.

The Richmond Fredericksburg & Potomac Railroad has placed orders for 6 coaches with the Bethlehem Shipbuilding Corp.

The Pittsburgh, Shawmut & Northern Railroad has placed an order for 1 passenger-baggage gasoline car with the J. G. Brill Company.

The Minneapolis, St. Paul & Sault Ste Marie Railway has placed an order with the Siems-Stembel Company for 10 milk car underframes.

The Raysonia, Nashville & Ashdown Railroad has placed an order for 1 passenger baggage gasoline rail motor car with the J. G. Brill Company.

The Newfoundland State Railways have ordered 2 sleeping cars from the American Car & Foundry Company.

The New York Central Railroad is inquiring for 10, 70 ft. passenger-baggage cars, and 2, 60 ft. all steel baggage-mail cars.

The Richmond, Fredericksburg & Potomac Railway has ordered 6 passenger coaches from the Bethlehem Shipbuilding Corporation.

The Chicago Rock Island & Pacific Railway is reported to be contemplating the purchase of a number of passenger cars.

The New York Central Railroad has ordered from the American Car & Foundry Company 5, 69 ft. steel baggage cars for the Cleveland, Cincinnati, Chicago & St. Louis, and 3, 69 ft. steel baggage cars for the Pittsburgh & Lake Erie Railroad.

Freight Cars

The Chicago, Milwaukee & St. Paul Railway is inquiring for bids covering the rebuilding of 1,000 box cars.

The United States Gypsum Company has placed an order for 25 mine car bodies with the American Car & Foundry Company.

The Fruit Growers Express is inquiring for 1,200 steel underframes for refrigerators cars.

The Quaker City Tank Line has ordered 200 refrigerators cars from the General American Car Company.

The Crozen Coal & Coke Company has ordered 25 mine trucks from the American Car & Foundry Company.

The General Electric Company has placed an order for 10, 50 ton steel underframe flat car bodies with the American Car & Foundry Company.

The International Railways of Central America has placed orders for two tank cars 4,300 gal. capacity with the Magor Car Corp.

The Chile Exploration Company has ordered 16 flat cars and 15 flat car bodies from the Magor Car Company.

The Hatfield Reliance Coal Company has ordered 50 mine cars from the American Car & Foundry Company.

The Standard Oil Company of Indiana is inquiring for 8 gondola cars.

The Pittsburgh Coal Company is inquiring for 700 mine cars.

The Peabody Coal Company has placed an order for 40 sets of roller bearing trucks with the American Car & Foundry Company.

The Chicago, Milwaukee & St. Paul Railway is inquiring for 500 gondola cars and 500 flat cars.

The Chicago, Rock Island & Pacific Railway has placed orders for 100, 50-ton gondola car bodies with the American Car & Foundry Company.

The Southern Pacific Company has placed orders for 3,200 freight cars as follows: 2,000, 50-ton single sheathed box cars with the Standard Steel Car Company; 1,000, 50-ton drop bottom gondolas with the Tennessee Coal, Iron & Railroad Company, and 200, 50-ton tank cars with the Pennsylvania Car Company.

The Tidal Refining Company, Tulsa, Okla., has placed an order for 60, 8,000 gal. capacity tank cars with the General American Car Company.

The Continental Coal Company has placed an order for 60 wooden mine cars with the American Car & Foundry Company.

The Swift & Company has placed an order for 100 underframes for refrigerator cars with the Bettendorf Mfg. Company.

The Raub Coal Company has placed an order for 12 mine cars with the American Car & Foundry Company.

The Atlantic Coast Line Railway has placed an order for 500, 40-ton box cars and 200 phosphate cars with the Tennessee Coal, Iron & Railroad Company.

A. Guthrie & Company, St. Paul, Minn., has placed an order for 6 standard gauge automatic air dump cars with the Koppel Industrial Car Equipment Company.

The Wabash Railway has placed an order for 75 center sill constructions for automobile cars with the Pullman Car & Mfg. Company.

The Shippers Car Line has placed an order for 20 tank cars with the American Car & Foundry Company.

The Chicago & Western Indiana Railroad has placed an order for 280 center sill constructions for gondola cars from the Pullman Car & Mfg. Company.

The New York Central Railroad has ordered 500 refrigerator cars from the Merchants Dispatch, of which 200 are for the New York Central and 300 for the Cleveland, Cincinnati, Chicago & St. Louis Railway. Also have ordered 100 air dump cars from the Clark Car Company.

The Carnegie Steel Company has placed an order with the Pressed Steel Car Company for 50 gondola car bodies.

The Detroit, Toledo & Ironton Railroad has ordered 20 side dump cars from the Clark Car Company.

The Kansas, City Mexico & Orient Railway will shortly enter the market for 350 box cars and 100 stock cars in connection with its reorganization and rehabilitation program.

Buildings

The Baltimore & Ohio Railroad has placed a general contract covering the construction of shed enclosure costing $30,000 at Cincinnati, Ohio.

The Delaware & Hudson Company plans to rebuild its machine and erecting shops at Carbondale, Pa., which were recently destroyed by fire.

The Pere Marquette Railroad plans an extension to its enginehouse in Wyoming yards at Grand Rapids, Mich., to cost approximately $75,000.

The car shops of the New York Central Railroad at Buffalo, N. Y., were badly damaged by fire.

The Illinois Central Railroad is reported to be planning the construction of a new terminal at Bluford Junction, Ill., on the new cut-off at Edgewood and has acquired a large tract of land there.

The Atchison, Topeka & Santa Fe Railway has awarded a contract covering the construction of a warehouse at Los Angeles, Calif.

The Southern Railway plans rebuilding its car and locomotive shops at Princeton, Ind., which were destroyed by the tornado.

The Oregon Short Line Railroad plans the construction of an enginehouse with repair facilities at Twin Falls, Idaho.

The Reading Company has awarded a contract covering the erection of a structural steel frame for the new freight car repair shop at Reading, Pa.

The New York, Chicago & St. Louis Railroad plans the construction of new locomotive and car repair shops, enginehouse, machine shop and other structures at Fort Wayne, Ind., estimated to cost approximately $2,500,000.

The Chesapeake & Ohio Railway plans the construction of a $500,000 boiler plant at Huntington, W. Va.

The Atlantic Coast Line Railroad plans extensive terminal improvements at Tampa, Fla., which will include a new yard with a capacity of 610 cars, ten miles of new track, an enginehouse with turntable, a repair with drop pit, blacksmith shop, oil house, storehouse, office buildings, coaling station, cinder hoist, water softening plant and other smaller buildings.

The Great Northern Railway plans the construction of a new terminal and a 25-stall roundhouse at Troy, Mont.

The Pere Marquette Railroad plans the construction of a new coaling station at Ludington, Mich.

The Kansas City Terminal Railway plans the construction of a storehouse at Kansas City, Mo.

The Atchison, Topeka & Santa Fe Railway plans the construction of a storehouse and shop superintendent office building at San Bernardino, Calif.

The Graysonia, Nashville & Ashdown Railroad announces that its shops at Nashville, Ark., which were recently destroyed by fire, will be rebuilt immediately.

The Texas & Pacific Railway plans for its new terminal at Dallas, Texas, including two freight houses, new yards, an eight-stall engine house and other facilities.

The Texas & Pacific Railway and the Missouri Pacific Railroad will expend $1,500,000 on port terminals at New Orleans, La.

The Southern Pacific Company plans enlarging its yards and constructing certain buildings at Marysville, Calif., to cost approximately $125,000.

The Norfolk & Western Railroad plans the construction of a larger enginehouse and an increase in its yard facilities at Portsmouth, Ohio.

The Clinchfield Railroad has plans prepared for its shops at Erwin, Tenn.

The Missouri-Kansas-Texas Railway plans the construction of a $6,000,000 warehouse in its yards at Houston, Texas.

The New York, Ontario & Western Railroad plans the construction of an electrifically operated coal trestle at Norwich, N. Y.

Items of Personal Interest

W. H. Flynn, superintendent of motive power of the Michigan Central Railroad, has been transferred to a similar capacity to the New York Central Railroad, with headquarters at New York.

Roy Mullins has been appointed night roundhouse foreman on the Santa Fe System, with headquarters at Winslow, Ariz., succeeding **A. H. Baldridge**, transferred to Riverbank, Calif.

E. H. Carlson has been appointed acting master mechanic of the Montana division of the Northern Pacific Railway, with headquarters at Livingston, Mont., succeeding **R. P. Blake.**

M. R. Reed, master mechanic of the Pennsylvania Railroad, with headquarters at Logansport, Ind., has been appointed assistant general superintendent of motive power of the Northwestern region, with headquarters at Chicago, Ill.

C. L. Gibson has been appointed master mechanic of the Stockton division of the Southern Pacific Company, with headquarters at Tracy, Calif., succeeding **H. H. Carrick**, who has been appointed to superintendent of shops, with headquarters at Los Angeles, Calif.

J. Archie Jones has been appointed general air brake supervisor of the Delaware & Hudson Company, succeeding **H. A. Flynn**, resigned, to enter the sevice of the New York Air Brake Company.

F. E. Myers, has been appointed division foreman on the Santa Fe System, with headquarters at Waynoka, Okla., succeeding **J. R. Clark**, who has been appointed division foreman, with headquarters at Amarillo, Texas.

J. F. Jennings has been appointed superintendent of motive power of the Michigan Central Railroad, succeeding **W. H. Flynn,** who has been appointed in a similar capacity for the New York Central Railroad. **F. P. Neesley,** division master mechanic, with headquarters at Jackson, Mich., has been appointed assistant superintendent of motive power, succeding Mr. Jennings. **C. W. Adams,** superintendent of shops at Jackson, has been appointed division master mechanic at Jackson, Mich., succeding Mr. Neesley. **W. R. Benson,** superintendent of shops at St. Thomas, has been appointed superintendent of shops at Jackson, Mich., succeding Mr. Adams.

H. H. Garrick, master mechanic on the Southern Pacific Railroad, with headquarters at Tracy, Calif., has been promoted to superintendent of shops at Los Angeles, Calif., succeeding **W. A. Rogers.**

W. F. Lauer, general foreman of shops of the Illinois Central, at South Memphis, Tenn., has been promoted to master mechanic, with the same headquarters, succeeding **O. A. Garber,** who has been appointed mechanical superintendent of the Missouri Pacific Railroad, with headquarters at St. Louis, Mo.

J. F. Corey has been appointed car foreman of the Union Pacific Railroad, with headquarters at Las Vegas, Nev., succeeding **T. F. Bledsoe,** resigned.

C. A. Knowles has been appointed valuation engineer of the Chesapeake & Ohio Railway, with headquarters at Richmond, Va., succeeding **R. B. Burks,** deceased.

C. W. Buffington was appointed district boiler inspector of the Eastern general division of the Chesapeake & Ohio Railway, with headquarters at Richmond, Va.

Joseph A. Russell has been appointed engineer of water service of the Pennsylvania Railroad, succeeding **Charles Haydock,** resigned to enter other business.

B. H. Prater has been appointed assistant chief engineer of the Oregon Short Line Railroad, with headquarters at Salt Lake City, Utah, succeeding **W. R. Armstrong,** transferred.

D. R. Snyder has been appointed inspector of transportation of the Atchison Topeka & Santa Fe Railway, with headquarters at Topeka, Kansas.

George H. Littlemore has been appointed road foreman of engines of the Montana division of the Northern Pacific Railway.

C. W. Chase has been appointed general manager for the receiver of the Chicago, Lake Shore & South Bend Railway, with headquarters at Gary, Ind.

F. G. Grimshaw has been appointed works manager of the Pennsylvania Railroad, with headquarters at Altoona, Pa., succeeding **P. F. Smith, Jr.,** who has ben granted a leave of absence from active duty on account of ill health. **R. G. Bennett** has been appointed general superintendent of motive power of the southwestern region, succeeding Mr. Grimshaw.

G. P. Brock has been appointed assistant general manager of the Gulf, Mobile & Northern Railroad, with headquarters at Laurel, Miss., succeeding **H. Gross,** who has resigned.

V. S. Andrus has been appointed assistant to general manager of the Southern Pacific Company, with headquarters at San Francisco, Calif., and the position of assistant superintendent of transportation has been abolished.

W. Corbett has been appointed superintendent of the Soo Line, with headquarters at Weyerhauser, Wis., and **F. W. Curtis** has been appointed superintendent, with headquarters at Minneapolis, Minn.

Julius Kruttschnitt has retired as chairman of the Southern Pacific Company and is succeeded by **Henry W. DeForest,** effective May 31. **William Sproule,** president, has his authority extended over all Southern Pacific lines excepting those of Texas. **Paul Shoup** becomes executive vice-president.

Supply Trade Notes

The Industrial Works, Bay City, Mich., manufacturers of locomotive cranes and crane equipment for more than a half century announces the opening of two new district offices, one at 425 Whitney Central Building, New Orleans, La., in charge of **John A. Abele,** district sales manager, and the other at 843-A Hurt Building, Atlanta, Ga., in charge of **John J. Murphy,** district sales manager.

That company also announces the appointment of four additional district sales engineers. **Douglas J. Calder, Conway J. Neacy** and **Monroe J. Frankel** will have offices at the Chicago district office of the Industrial Works, 1051 McCormick Building, Chicago, Ill., and **Chester F. Delbridge** will be located at the St. Louis district office, Railway Exchange Building, St. Louis, Mo.

S. G. Down, vice-president of the **Westinghouse Air Brake Company,** was elected a member of the board of directors at the last annual meeting of the stockholders of that company, which was held at Wilmerding, Pa., on April 15th. Mr. Down fills the vacancy on the board created by the late **Morris Rosenwald,** of Chicago, who died March 27, 1924.

Mr. Down's career with the air brake organization forms a striking illustration of the opportunities offered by the company to those who enter its service. He came with the company on January 1, 1902, and the first duty assigned to him was that of an instructor on the instruction car. Since then he has advanced through the various positions of air brake inspector, mechanical expert, district engineer, assistant district manager, district manager, president of the Westinghouse Pacific Coast Brake Co., and general sales manager, until he was elected vice-president in January, 1923, which position he now holds.

Walter Bentley, of the advertising department of the "Railway Journal," has been appointed sales manager of the **Waugh Equipment Company,** with headquarters in Chicago, Ill.

The Falls Hollow Staybolt Company, Cuyahogo Falls, Ohio, has opened a new office at 203 E. 50th St., New York City, in charge of **L. Wechsler,** sales representative.

P. B. McGinnis, mechanical expert of the **Westinghouse Air Brake Company,** with headquarters in Chicago, Ill., has resigned to become representative of the **Six Wheel Company,** Philadelphia, Pa., manufacturers of six-weel automobile highway buses, with headquarters in Chicago, Ill.

The Galena Signal Oil Co., Franklin, Pa., has acquired the plant of the Sibley Soap Co., and will remodel it for the production of oils and greases.

A. H. Palmer has been appointed chief engineer of the Otis Steel Company, succeeding **R. E. Brakeman,** resigned.

J. H. Kelly and **F. V. Springer** have acquired the **Hewitt Rubber Co.,** Buffalo, N. Y., and Mr. Kelly has been appointed president and Mr. Springer first vice-president. There were no other changes in personnel involved.

The Ralston Steel Car Co., Columbus, Ohio, has placed a contract for three buildings including a wheel and axle building and addition to the main building and storage building.

The Symington Co. has moved its New York office from 1936 Woolworth Building, to 250 Park Avenue, New York.

The general offices of the **Nathan Manufacturing Co.,** New York, N. Y., has been transferred from 21 East 40th Street to 250 Park Avenue, New York.

A. A. Paoli has been appointed manager of the Winnipeg, Man., office of the **Canadian Ingersoll-Rand Co.**

The American Locomotive Company plans the construction of a hammer shop at Dunkirk, N. Y.

The Bird Archer Company from now on will conduct its Canadian business entirely from a general office which will be located at 300 McGill Building, Montreal. Previously the Canadian business has been conducted from the head offices at New York. **Hugh C. Harragin** will be in charge of the administration of the Canadian business, with head offices at Montreal.

The Safety Air Brake Co., has been incorporated at Wilmington, Del., to manufacture mechanical compressed air devices.

Wallace J. Goodrich, who has been representing the **Benjamin Electric Mfg. Co.,** in Chicago, Ill., for the past six years, has been appointed manager of the railroad department of that company.

The Truscon Steel Co., Youngstown, Ohio, has leased a site at Buffalo, N. Y., and will construct two warehouses thereon.

The Chicago district sales office of the **Whiting Corp.,** in charge of **R. S. Hamond,** district sales manager, has been moved from 945 Monadnock Block to 1502 Railway Exchange, Chicago, Ill.

The Gould Coupler Co., will change its address from 30 East 42nd Street, New York, N. Y., to the 16th floor of the Poston Building at 250 Park Avenue, New York.

Charles D. Little has been elected vice-president in charge of sales for the **Crane Co.,** and has also been elected a member of the board of directors. **H. W. Seymour,** formerly branch manager at Baltimore, Md., has been appointed general manager of sales, succeeding Mr. Little.

The Anti-Hotbox Co., Princeton, Ill., has been incorporated to manufacture a cooling compound by **W. O. Stevens** and associates.

Robert R. Cuthbertson, formerly manager of the Chicago branch of **Manning Maxwell & Moore, Inc.,** has resigned.

The Railway Car Forging Co., 20 West Jackson Boulevard, Chicago, Ill., has been incorporated by **Charles Aaron, E. M. Aaron** and **C. E. Clark,** to manufacture iron, steel and metal products for railways.

A. M. Jones has been appointed assistant sales manager of the **Buffalo Bolt Co.,** North Tonawanda, New York, and **H. B. Bevan** has been appointed district manager at St. Louis, Mo., succeeding Mr. Jones.

The Air Reduction Sales Co., New York, N. Y., has commenced construction of a plant at Kansas City, Kan., for the manufacture of welding apparatus, etc.

The National Malleable & Steel Casting Co., Cleveland, Ohio, announces a new address for its branch sales office in Chicago. The new office will be located at 501 Railway Exchange, Chicago, Ill., instead of 311 Railway Exchange, as formerly.

The Brown Hoisting Machinery Company, Cleveland, Ohio, has made the following appointments in its sales organization: **J. P. Case**, sales manager; **J. F. Poland**, manager of Chicago office; and **E. W. Taylor**, manager of Pittsburgh office. In addition to his duties as sales manager, Mr. Case will be in charge of the Cleveland division sales.

The Elvin Mechanical Stoker Company will remove its executive offices from 50 Church Street to the third floor of 30 Church Street, New York, N. Y.

The U. S. Light & Heat Corporation will remove its New York district office from the Grand Central Terminal to 161 West 64th Street, New York, N. Y.

E. S. Jackman & Company, agents of the **Firth-Sterling Steel Company**, has removed from 333 Frankfort Avenue, Cleveland, Ohio, to their new warehouse and office at 1424 East 25th Street, N. E. Cleveland, Ohio.

Benjamin Nields, Jr., sales agent for the **National Malleable & Steel Castings Company**, Cleveland, Ohio, will remove his office from 30 Church Street to 17 East 42nd Street, New York, N. Y.

Harry B. Gilmore, for the past 17 years manager of the distributing organization of the **Western Electric Company**, at Boston, Mass., has been elected secretary of the company. A few months ago he was made assistant secretary and was transferred to New York. He succeeds as secretary **George C. Pratt**, who in the future will devote his entire attention to his duties as general attorney. **Donald S. Pratt** was elected an assistant secretary.

The patent litigation which has been going on since 1911 between **The Safety Car Heating & Lighting Co.** and the **U. S. Light & Heat Corporation**, and its predecessor, The United States Light and Heating Co., recently resulted in a judgment against the U. S. Light & Heat Corporation for over $500,000. The parties have agreed to settle this judgment by the sale of The Safety Car Heating & Lighting Co. by the U. S. Light & Heat Corporation of all of its patents, machinery, equipment and inventory used in, or connected with car lighting. This sale does not include USL arc welders or the USL batteries. The U. S. Light & Heat Corporation will therefore continue to manufacture and sell arc welders and a complete line of batteries including train lighting batteries.

C. E. Donegan has been made district sales manager of the **Linde Air Products Co.**, at Minneapolis, Minn; **W. A. Kopp**, at Birmingham, Ala., and **G. D. Grubb**, at Tulsa, Okla., all newly opened offices.

OBITUARY

Sir Wm. Acworth, K. C. S. I., internationally known railway authority, died last month in London. Sir William had been called into consultation several times in regard to American railways and served on the royal commission of inquiry which recommended the nationalization of the Canadian lines in 1916. Sir William was a director of the Underground Electric Railways of London; a member of the council of the Institute of Transport and a member of the Railway Nationalization Society.

New Publications

Books, Bulletins, Catalogues, etc.

Adequate Transportation Facilities, the Basis for Industrial and Social Progress—Telling the Public the Facts is the subject of Special Publication 1720 recently released by the Westinghouse Electric and Manufacturing Company. During past years this company has been responsible for regular appearances of public relations good will advertisements in several of the leading popular media of the country. In this recent publication, the past endeavor in this direction is crystallized in the reproduction in color of eighteen of these public relations messages.

The messages incorporated in the type of advertisements that have appeared, are intended to impress on the mind of the public the dependency which it has to place on the transportation system and because of which it is for the public to encourage and support the electric railways. By these messages also the public has been acquainted with the problems of this utility from several angles.

The Westinghouse Company in this way is earnestly endeavoring to do to the industry and with the courage of its convictions, has resolved to continue its work. Many expressions of appreciation which have been received tend to strengthen its faith in this work.

The messages contained in the book are not restricted. Any railway company has the privilege of using the messages in the interest of their own service.

Copies of the publication may be obtained from any district office or from the Publicity Department at East Pittsburgh.

Riding the Ridge of the Rockies is the title of a booklet just issued by the Chicago & Northwestern Railway. It describes in detail horseback and camping trips into the Jackson Hole country, the wild, rugged and marvellously beautiful section of mountainous country lying beyond the rails' end at Lander, Wyo., and south of Yellowstone Park—a country practically unknown to the average tourist and, as the booklet fittingly names it, the "last west." The booklet is profusely illustrated with scenes in camp and along the train, and contains an excellent map of the Jackson Hole country as well as of Yellowstone Park.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

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The First Virginian Electric Locomotive

By E. I. Staples, General Engineer, Westinghouse Electric & Manufacturing Company

The first of the electric locomotives for the Virginian Railway was formally tested and demonstrated on May 14 before a gathering of the officials of that Company at the East Pittsburgh Works of the Westinghouse Electric & Manufacturing Company.

It will be remembered that the Virginian electrification contract was the largest ever awarded, amounting to $15,000,000, all electrical apparatus to be furnished by the Westinghouse Company, the mechanical parts of the locomotive, such as trucks and cabs were supplied by the American Locomotive Company. It called for thirty-six motive power units, the normal road locomotive to consist of three of these units semi-permanently coupled together to form the largest and most powerful locomotive in the world. This locomotive measures 152 feet in length, weighs 1,276,000 pounds, and develops a maximum tractive effort of 277,500 pounds.

First Electric Locomotive Completed for the Virginian Railway by the Westinghouse Electric & Manufacturing Company

The electrification includes 133.6 miles of route and 213 track miles. The power plant for supplying the 11,000-volt alternating current is rapidly nearing completion. A part of the overhead catenary structure has been installed and the remainder of the locomotives will be shipped on a schedule of one and two locomotives per month. It is expected that complete electric operation of this section will be inaugurated before the close of the year 1925.

The Virginian Railway was conceived and built for the sole purpose of moving coal from the rich New River and Pocahontas fields to tidewater at Norfolk. From the very beginning this road has been noted for heavy rolling stock, large trains and high operating efficiency. The part of the road which is being electrified, between Mullens, West Virginia and Roanoke, Virginia, has offered the most difficult operating problems because of the heavy grades. A condensed profile of this section is shown in the illustration. The grades east of Roanoke are easy and the movement of tonnage on this part of the road has never presented serious difficulties.

Nearly all of the Virginian coal tonnage originates west of Elmore. At present, trains of approximately 5,500 gross trailing tons are made up in the yard between Mullens and Elmore and are moved up the 2 percent grade between Elmore and Clark's Gap by means of a road engine and two pushers of the 2-10—10-2 type. The combined weight of the locomotives in this train including their tenders is approximately 1,270 tons, and their combined tractive effort ratings is 409,400 lb.

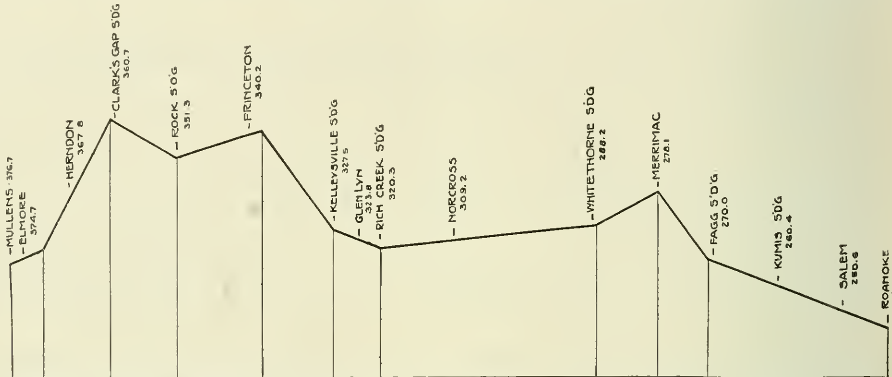
There is no other place in American railroading where such a concentration of motive power is regularly applied to single trains. From Clark's Gap, the 5,500-ton train is taken into Princeton with the single 2-8—8-2 road engine.

The division offices and general shops of the Virginian are located at Princeton, which is a terminal point under steam operation. Trains operated from here to Roanoke are usually made up to about 8,000 gross trailing tons and are handled by one 2-8—8-2 road engine, with the assistance of two switchers to start out of Princeton yard and of a Mallet engine up the grade between Whitehorne and Merrimac.

line, and locomotives have been designed for either 11,000 or 22,000 volts between the trolley and rail.

Electric Locomotives

The locomotives which will be used on this electrification and the first of which has just been demonstrated, are known as the split-phase type. The first locomotive completed is shown in the frontespiece illustration. Power is taken from the overhead wire through the pantagraph to the main transformer where the pressure is reduced from 11,000 to a comparatively low motor voltage. The single-phase power is changed into three-phase power by means of the main transformer



MILES *		5.06	10.32	10.05	12.97	10.90	7.21	32.72	9.31	7.43	27.56
ELEVATION	1427.03	1528.42	2525.99	2232.61	2438.16	1674.13	1534.96	1700.55	1966.57	1445.86	916.9
COMPENSATED GRADE PER CENT	EAST	+.531	+1.979	−.396	+.402	−1.259	−.340	+.163	+.585	−1.252	−.313
	WEST	−.228	−1.681	+.710	−.198	+1.335	+.391	−.024	−.475	+1.400	+.401
MAXIMUM GRADE %		1.21	2.11	1.25	0.60	1.50	0.808	0.20	0.60	1.5	0.9
AVER. CURVE Deg		3.79	3.73	3.93	2.55	1.70	0.64	1.80	1.35	1.85	1.10
MAX. CURVE Deg		12°	12°	12°	8°	8°-10'	3°	8°	9°	8°	8°
MILES from NORFOLK (From Mile Posts)	376.73	371.67	361.56	351.33	330.40	327.49	320.29	287.59	278.10	270.67	245.11

* SURVEY EQUATIONS INCLUDED

Profile of Virginian Railway Electrified Line from Mullens to Roanoke, Va.

The coal fields served by the Virginian have hardly been scratched and it is realized that the coal tonnage will steadily increase. The management saw that extensive improvement and additions, both to way and rolling stock would be necessary to meet these traffic increases and a careful analysis by engineers of the railway assisted by those of the Westinghouse Electric & Manufacturing Company showed that it would be more economical to electrify the part of the road between Mullens and Roanoke.

A system of electrification was selected which would permit the handling of heavy trains and which would allow ready and economical expansion. The high voltage alternating current system was chosen after careful consideration of it and of the direct current system.

Power for the electrification will be supplied from a power plant being constructed at Narrows, Virginia. The railway officers felt that traffic movement should not be subordinated to power demand and the use of the railway owned and operated power plant avoids the power limiting devices which usually become necessary when purchased power is used for a railway load. Power from this new power house will be fed each way on 88,000-volt transmission lines and from these lines to the overhead catenary system by means of transformer stations located along the right of way. In order to provide for the application of greater power to trains with growth of traffic, the transformer stations, trolley

and a rotating machine, called a phase converter, whence it is fed to the main traction motors. The latter are induction motors arranged for two comparatively constant running speeds of 14 and 28 m.p.h. These motors which have very desirable constructional and operating characteristics for locomotive use are simple and rugged in construction and have a high weight efficiency. The constant speed operating characteristics is considered a distinct advantage on the Norfolk and Western where locomotives of this type have been in successful operation since 1915. It should be remembered that the amount of energy required to move a train over a profile is affected by speed only as speed affects train resistance and in mountain grade movement the latter is usually a small part of the total tractive effort.

The three semi-permanently coupled motive power units are operated as a single unit, and only the controller in the front end of the leading cab is used at one time. Acceleration to the running speeds is obtained by varying the resistance in the secondary or rotor circuit of the traction motors, a liquid rheostat being provided for this purpose. The amount of resistance is determined by the height of the electrolyte in the rheostat and this is directly controlled by the engineman through the master controller. The master controller essentially consists of two parts, a speed drum for changing the motor connections to secure the desired running speed, and an acceleration drum. The control position also includes an auxiliary controller in which are placed switches for operating the pantagraph, buttons for independent operation of the different rheostats, and a button for tripping the circuit breakers.

An especially interesting feature of these locomotives is the oil insulated force cooled transformer, the windings and core being immersed in a tank of oil. The oil is continuously circulated through a special radiator by a motor driven centrifugal pump and air for the radiator is supplied by a blower driven by the same motor which drives the pumps. By using this type of transformer, the advantages of the oil insulated transformer are secured without the space required by the self-cooled type.

The locomotives are automatically regenerative; that is, when descending a grade of such amount that the net tractive effort becomes negative, the motors become generators and return power to the line. Thus, it is necessary to use the air brakes only to bring the train to a complete stop and this results in no considerable saving in brake shoes and brake rigging maintenance.

While the motive power units will at first normally be used in groups of three as road locomotives, the control, which is of the electro-pneumatic type, is arranged to permit the operation of four cabs together. Thus future traffic conditions are amply provided for, both from the standpoint of power supply and locomotive capacity.

Each motive power unit has the Mikado or 2-8-2 wheel arrangement, the weight per cab being approximately 425,000 lb., so that the weight of the three cab road engine is 637.5 tons. Each driving motor has mounted at each end of the shaft a pinion which meshes with a flexible gear and the gears are mounted on a jack shaft, the power being transmitted from the gear centers to the drive wheels by means of side rods. The mechanical design has numerous features and improvements which have resulted from a careful study of the Virginian requirements.

The maximum tractive effort of each motive power unit as limited by electrical capacity is 92,500 lb. which occurs at an adhesion slightly under 30 per cent. At the conservative starting adhesion of 25 per cent, the tractive effort is approximately 77,000 lb. per unit or 231,000 for the three unit road locomotive. This is 57 per cent greater than the compound rating of the 2-10—10-2 steam pusher engine and 31 per cent greater than the simple rating. The continuous tractive effort of the three cab locomotive is 135,000 lb. at 14.2 m.p.h. and 78,800 at 28.4 m.p.h.

In the high speed connection of the motors the locomotive can exert 6,000 horsepower continuously.

Under electric operation the coal trains will be made up in the Mullens-Elmore yard, as at present, and a three unit road engine at the head end of the train with a similar pusher at the rear end will handle 6,000 gross tons from Elmore to Clark's Gap. The speed will be 14 m.p.h. which is double that obtained at present with steam and 12,000 horsepower will be produced at the locomotive drive wheels. At Clark's Gap the trains will be filled out 50 per cent to 9,000 tons, and the three unit road engine alone will take this train to Roanoke. It will not be necessary to use pushers out of Princeton or up the Whitehorne grade. The speed will be 14 or 28 m.p.h. depending upon the grade and the time between Elmore and Roanoke should be less than 10 hours.

The west bound trains will consist almost entirely of empty coal cars and will be handled with one road locomotive at a speed of 28 m.p.h. except from Fagg to Merrimac, from Kellysville to Princeton, and from Rock to Elmore. The weight of these trains will be about 2,800 tons.

While a great proportion of our railway trackage will not admit of economical electrification for many years, there are a number of difficult operating districts, such as that of the Virginian, which could be economically electrified.

Present Type of Virginian Railway Steam Pusher Locomotive

Japanese Railways Order Three-Cylinder Locomotives

The American Locomotive Co. has received an order from the Imperial Government Railways of Japan for six Pacific type superheater locomotives weighing 192,000 pounds. These locomotives will be the most powerful passenger locomotives in service in Japan. They will be equipped with the same three-cylinder principle with which the American Locomotive Co. is having success in this country. This order not only makes the eleventh railroad that has ordered or has in service three cylinder locomotive design, but it also makes the second order for this design of locomotive which has been received from the far east—the first order being for five locomotives for the South Manchurian Railways, which were shipped in June, 1924, and which have proved very successful in service.

Cars and Engines Inspected

The Bureau of Locomotive Inspection of the Interstate Commerce Commission inspected 6,635 locomotives during April, according to the monthly report of the Interstate Commerce Commission to the President on the condition of railroad equipment. Of these 3,030, or 46 per cent, were found defective and 291 were ordered out of service. The Bureau of Safety during the month inspected 101,037 freight cars, of which 3,002, or 3 per cent, were found defective, and 2,475 passenger cars, of which 23, or 0.9 per cent, were found defective. During the month 12 cases, involving 21 violations of the safety appliance acts, were transmitted to various United States attorneys for prosecution.

The Economics of Shopping Steam Locomotives

By L. K. SILLCOX, General Superintendent of Motive Power, Chicago, Milwaukee & St. Paul Ry.

Abstract of a Paper Presented Before the American Society of Mechanical Engineers

It is a well-established business principle that it is essential to success that a manufacturer should know the cost of his product; and it is quite as essential that a railroad company should be equally well posted as to the cost of its locomotive maintenance. The serious question in the case of a railway is the decision of an accurate unit of measure.

As for the items to be included in the cost, they are provided for by the Interstate Commerce Commission classification and include all labor, material and overhead as well as a depreciation, the rate of which is left optional with the company. And this with the annual cost of maintenance will average approximately 15 per cent of the initial cost per year.

It sometimes happens, however, that the actual repair cost exceeds the major portion of the value of the unit as renewed. The folly of spending large sums in maintaining obsolete designs, can, at times, be made very apparent. Let us test this by imagining a concrete case. Assume that a passenger engine fifteen years old and originally designed to handle a nine-car train is now required to carry fifteen cars on the same schedule resulting in a heavy maintenance cost due to frame breakages, racking of machinery, valve motion, running gear, etc. If the original unit was of 40,000 lb. tractive effort and was costing an average of $9,000 per year to maintain with a relatively low record of 3,000 miles per month, then it would seem proper to consider a new type of power, say, with 50,000 lb. tractive effort which would afford 5,000 miles of service per month and yet not cost more than $5,000 per year for maintenance, making a saving of approximately $4,000 per year in maintenance cost and increasing the performance 66 per cent. This would justify making a change in power even though the original unit might have cost $30,000 and the new unit would cost $60,000. The original unit involved a maintenance cost of $9,000 per year plus a depreciation charge of $750, or a total of $9,750 as compared with an estimated maintenance cost of $5,000 per year for the new unit plus $1,500 depreciation charges or a total of $6,500, making a saving in the new unit of $3,250 per year, to say nothing of additional savings in fuel and transportation expenses. At 6 per cent this recovery would represent an investment of $54,000, or almost the cost of the new unit, but if this were done on a large scale then the amount of work would be performed with 66 per cent of the number of new units as compared with the number of old units, and thus the change would be justified.

Such a case as this would be more applicable to freight than to passenger service because of the greater constancy of the latter.

As to obsolescence, it is a very indefinite measure and is quite dependent upon local conditions. In fact a locomotive may grow obsolete if it only remains standing.

The same idea of promoting efficiency may be applied to the method employed in shopping locomotives. There are many elements in the matter of executive policy which go to make a relatively high or low maintenance cost, and the method of shopping power is one of the primary features to be considered, and it may be said that the policy used in the matter of shopping power becomes a central factor, and may be considered as the hub of the force at play. There are two extremes of policy in the many variations between them. One is what may be termed the "high-frequency-shopping" and the other the "low-frequency-shopping" policy. The high-frequency-shopping policy is that based on running locomotives through shops with an anticipated service of from twelve to fourteen months with a minimum of roundhouse attention. The low-frequency-shopping policy is that based on running locomotives through shops with the idea of having a service of 24 months or more and with a greater degree of roundhouse attention to attain this length of service. Vital elements in determining such a policy are the relation of the number and size of locomotives owned to the business handled, the road conditions

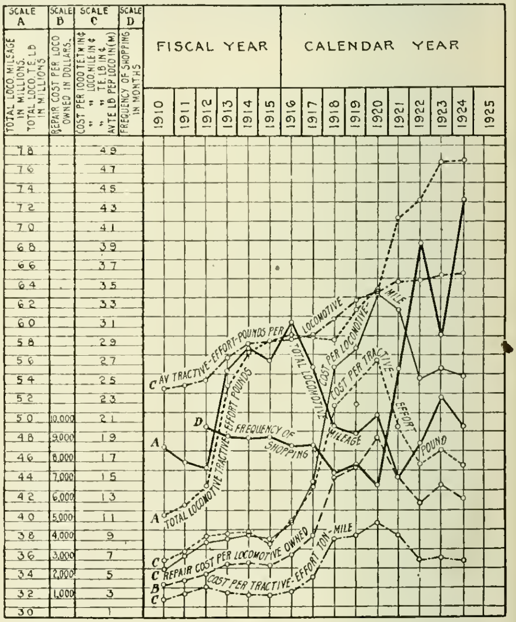


Fig. 1—Data of Steam Locomotive Repairs Showing Results of Changing from a High to a Low Frequency Shopping Program

for hauling heavy- or light-tonnage trains, the topography of the country traversed, the distribution of industrial centers, the presence of large terminals, the spacing and capacity of roundhouses, the distribution and assignment of power, the placement of forces as between roundhouses and back shops, the rapidity with which mileage is run out, and particularly the roundhouse and back-shop facilities for handling certain classes of work. Furthermore, where a railroad has back shops of an obsolete character it is practically as well off doing its work in roundhouses, and it may be found helpful under such conditions to construct small modern back-shop facilities at critical points to care for division requirements without increase in overhead expense.

Close observation shows that policy is largely governed by local conditions rather than local conditions being governed by policy. The road with which the author is connected has had experience under both plans, and just as a case in point, the general results obtained will be stated. Prior to 1921 a high frequency of back-shop repairs was employed, but after considerable study the plan was changed to a low frequency of repairs. The trend of unit costs, etc., both prior and subsequent to 1921, is illustrated in Fig. 1. This chart is a graphic illustration of the results obtained under these two extremes of policy, affected, of course, by the price trend of labor and material in the meantime. The lines plotted represent three general groups, one indicating the growth and size of units maintained, another the various unit costs of maintenance, and a third the frequency of back-shop repairs. The growth of property maintained is represented by the dotted line *A*, which indicates the total tractive-effort pounds owned from 1910 by years to the end of 1924. This growth was not all in the nature of new equipment but represents power added by the acquisition of subsidiary and leased lines as well as some new equipment, and to that extent the growth line should not be confused with the rate at which new equipment might have eliminated obsolescence. This very fact has a marked bearing on the cost of maintenance, as the total growth consisted of approximately as many of the smaller and older locomotives as of the acquisition of the larger and newer types. The growth of property represents a serious problem in the matter of having back-shop development keep pace with it and of getting continuous use from power. Fig. 1 also shows the increase in the average size of locomotive expressed by the mean tractive-effort pounds per locomotive owned. The size of locomotives is an element in the unit cost of maintenance, and it will be noted that this figure increased from approximately 24,000 tractive-effort pounds per unit to 36,000 in 1924, or approximately 50 per cent. The chart is confined to steam locomotives only.

The feature in Fig. 1 which is deserving of closest study is the line D representing the frequency of back-shop repairs. This is arrived at by dividing the total yearly classified-repair output into the total owned throughout the year, which expresses the number of years between shoppings thus developed, and this of course varies from year to year according to the difference in the number of locomotives owned or used and the output. This is based upon a classification of repairs instituted during federal control and is translated back to 1912.

The variation in the trend of line *D* is entirely dependent upon the allotment of labor and materials available for maintaining equipment. The shopping frequency increased gradually from 1912 to 1920, and during the latter year locomotives were going through at the rate of once every 14.28 months. In 1921 a committee was appointed to report upon the economics of shopping power, as a result of which it will be noted there was a radical change in the frequency of back-shop classes of repairs subsequent thereto. This study related particularly to the situation existing on the Chicago, Milwaukee & St. Paul Railway and is not offered as a criterion for the reason that other conditions often determine whether or not such a policy is applicable to any but a specific case. The frequency of shopping trend, expressed both in years and in months between shoppings, was as follows:

Year	Years between shoppings	Months between shoppings
1920	1.19	14.28
1921	2.20	26.40
1922	3.30	39.60
1923	2.50	30.00
1924	3.70	44.40

The change in plan necessarily brought about some modification in the distribution of machine tools and facilities in back shops and roundhouses. Great care had to be employed to avoid deferred maintenance under such a transition because of the high cost incident to overcoming deferred maintenance promptly and adequately were this condition to have obtained. The roundhouses were partially equipped to do the necessary machinery and running repair work and in some cases rather heavy boiler work so as to properly maintain the power for longer periods, some of the facilities being transferred from the back shops to the roundhouses. The back-shop forces were reduced in proportion. Prior to the change all judgment as to months good for, miles to be run between shoppings, etc. was based on the theory that locomotives were good for a term of 12 months only, and consequently a large amount of data was prepared to show that this attitude was not in keeping with the operation of the property and therefore should be adjusted to the new method. Prior to 1921 there was no specific application of the plan of assigned mileage to be used as a basis for shopping power. This method was put into use at that time and a statement prepared showing the expected mileage to be run out after each classified repair, divided according to types of power. It is important that the same mileage should not be applied to the same type of power regardless of where or how used, and in this respect an assigned mileage for each class of service, type of power, and for each division instead of for the system as a whole is necessary in practice, otherwise classified repairs will be made in roundhouses, but not so reported, in order to avoid breaking the mileage. The method of breaking mileage varies throughout the country, but this does not affect the data used here. As to the results obtained from this change of plan, it should be understood that there have been some wage and material price variations since 1920, but these adjustments account for approximately 14 per cent of the reductions attained. The cost trends on the chart merely indicate the actual reductions, with no separation between fluctuations in the cost of material and labor, shop efficiency, etc. The cost per locomotive-mile during the high-wage period of 1920 reached 34 cents when the shopping frequency was 14.28 months, but after the frequency of back shopping was reduced the cost steadily declined and in 1924 was less than 26 cents. This represents a reduction of approximately 24 per cent. The cost per tractive-effort pound was reduced from 27 cents in 1920 to 16.5 cents in 1924, or 39 per cent. The cost of repairs per locomotive owned was $9,300 in 1920 and $6,000 in 1924, or a reduction of 35 per cent. The cost per thousand tractive-effort ton-miles was reduced from 1.075 cents in 1920 to 0.676 cent in 1924 or 37 per cent. In the meantime the average size of locomotives increased 6 per cent. The method of measuring the cost of repairs per tractive-effort ton-mile was to take the tractive-effort pounds owned, reduce them to tons, multiply by the miles run in thousands, and divide this into the cost of repairs. As previously stated, there were reductions in wage rates and cost of material in this period, so that the entire reduction is not to be credited to the change in plan referred to.

Finally, we have seen that this principle of shopping locomotives is in no sense special or peculiar. As to whether or not a policy as outlined could be taken as a criterion, it would be difficult to state. The plan was adopted for the C. M. & St. P. system because it appeared to be properly applicable. It is a matter of interest in this connection, however, to make a study of ten carriers where there is a wide range of policy, using the same units outlined above.

The method employed should not be considered as absolute. The chart of Fig. 2 is offered as a result of a study of various carriers, some having a high-frequency and some a low-frequency method. The horizontal scale is the average tractive-effort pounds per locomotive owned. The data are based on 12 months in 1924.

Another point may be observed. In the matter of per-

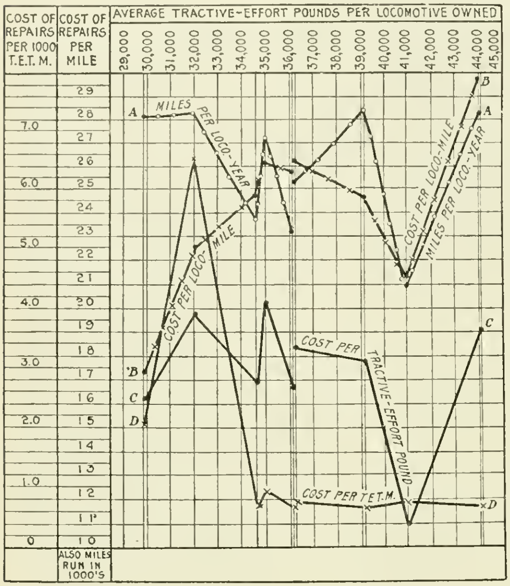


Fig. 2—Comparison of Cost of Maintaining Steam Locomotives Considering Average Size, Average Miles, and Cost of Repairs per Mile per Tractive-Effort Pound and per 1,000 Tractive-Effort Ton-Miles

formance the average miles per locomotive run per year is given by line *A*. This shows a difference in performance which does not follow relatively the variation in size of power, indicating many degrees in intensity of use, etc. The mileage ranges from 20,800 to 28,500 per locomotive per year. The carrier with the largest size of power made practically the same mileage per locomotive as the one with the smallest size of power shown on the chart, whereas those administrations with locomotives of a size ranging between the two extremes made less mileage per locomotive. This may be considered an element of performance and demand characteristics of the lines involved. In this case the highest mileage was 37 per cent greater than the lowest shown.

The cost per locomotive-mile as shown by line *B* is low for the carrier having the smallest size of power, being less than 17.5 cents, and is high for the one having the largest size of power, the upper range being a little less than 30 cents per locomotive-mile. The average size of power expressed in tractive-effort pounds was 47 per cent greater in the largest average size as compared with the smallest average size, whereas the cost per mile was 71 per cent greater for the larger than the smaller power, so that it may be said that in this case the cost inceased one and one-half times as the unit size of power increased. This figure is not in itself entirely significant.

The cost of repairs per tractive-effort pound being a measure of size only, does not run in direct ratio with the increase in size. It will be noted that while the smallest size of power has the lowest cost of repairs, the largest size of power does not have the highest cost of repairs, both being exceeded by carriers having locomotives of intermediate capacities. The composite factor of cost of repairs per thousand tractive-effort ton-miles, consisting of the size and mileage, ran somewhat inversely with the capacity of power owned, with variations in the intermediate sizes. Here it is interesting to note that the smaller size of power cost more than the larger, the result being due in this case to the carrier with the larger power running about the same mileage per unit as the carrier with smaller power.

It would, however, be difficult to establish a criterion or a specific policy that would be applicable to all cases.

These data indicate that as the average tractive-effort pounds owned increases, the cost of repairs per mile increases in a rather definite way; that the average miles per locomotive run and the average cost of repairs per tractive-effort pound have the same range characteristics; and that the aveage cost of repairs per thousand tractive-effort ton-miles varies somewhat inversely with the average tractive-effort pounds per unit owned, with intermediate fluctuations.

Just what effect the specific policy followed has upon the trend of the cost of repairs is not thoroughly ascertainable, but it would seem that a minimum cost may be expected when it has been definitely established that a proper balance between classified and running repairs has been arrived at. A study of the cost of repairs per mile divided between running and classified work does not present a solution, because whenever it is necessary to decrease or increase forces and expenses, the fluctuation is felt directly in the back shop and only indirectly in the roundhouse. It is generally known, of course, that whenever it becomes necessary to curtail expenses or make reductions, it is a simple matter to close the back shops but not possible to make corresponding reductions in roundhouses because certain forces must be maintained in the latter at all times.

One way of measuring performance with shop output is to compile the locomotive-miles run since last shopping, setting this up in a cumulative way monthly and comparing it with the miles restored in classified repairs. The miles restored must necessarily be based on the assigned mileage, and the balance between miles run out and restored cannot be accurately judged unless the assigned mileage is practically correct and consistent with actual performance. When the assigned mileage is set too high, then there will be more restoration of mileage reported by shop output than is actually run out; on the other hand, if the assigned mileage is too low, then the restoration is not in keeping with the run-out mileage. The experience of th C. M. & St. P. along this line has developed the fact that the application of the assigned mileage for each type of power, regardless of its use, is not sufficiently specific, and such process, when employed, needs revising by developing an assigned mileage for each type of power and for each division so that the local characteristics as to track, curvature, gradients, service, consequent tire and lateral wear, and boiler repairs can be considered as factors.

The factors used by the author's read in the general plan of shopping are assigned mileage, time, and actual physical condition based on customary and frequent inspections. Where there is a low rate or run-out mileage, time enters into the calculation to a greater degree than where mileage is run out rapidly.

In the regulation of the frequency of repairs it has been the company's general policy to have two minor repairs between two major repairs, but this depends upon the nature of the service performed as well as upon the rapidity with which the mileage is run out.

We have not been able to observe any adverse effects on engine house turning because of a decrease in the frequency of back shop repairs; it might have been assumed that so low a frequency as was developed in the change of policy would throw too much of a burden upon roundhouses for intermediate repairs and increase the hours of detention. The cost per mile of running repairs incurred in roundhouses is greater than the cost per mile of classified repairs made in the backshops, the former running rather uniformly with the number of engines turned and the latter fluctuating more in relation to increase or decrease in operating expenses because of regulating them according to revenues.

It has been found when comparing the performance of a greater number of carriers than used in plotting Fig. 2 that the tendency to run out locomotive-miles rapidly increases somewhat with the increase in size of power, and, as before stated, the rate at which mileage is run out is a determining factor in the proper fequency of classified repairs.

In cases where the percentage of power in service is low as compared with the total owned it is usually found that the hours of service per day are low or approximately six, which makes it possible to have a large waiting list and to turn locomotives less rapidly through the shops and still have ample protection for service.

Some Freight Car Maintenance Problems*

By C. G. JUNEAU, Master Car Builder, Chicago, Milwaukee & St. Paul Railway

Undoubtedly the greatest problem today in connection with freight car maintenance revolves on the constant endeavor of the railroad to obtain the maximum use of the car unit. The utilization of cars is the product of their loading and their movement. Successful attempts are continually being made to load each car with greater tonnage, and to increase the distance each car is hauled per day. Again, wherever there is an opportunity to fit the trains to the traffic, this is being done so that the tonnage will be handled in fewer trains, and thus effect a saving in those transportation expenses that fluctuate with train mileage. The trend of this endeavor to obtain greater use of cars and trains is shown in Fig. 1.

Along with this steady increase in the utilization of the freight car has gone a steady change in the construction and strength of the car. The all-wooden car is fast disappearing and its place is being filled by the composite car and the steel car. During the past 20 years the average carrying capacity of freight car has increased from 29.4 tons in 1903 to 43.1 tons in 1922. The light weight of cars has also increased. The all-wooden box cars acquired in the 1880's weighed from 14½ to 16 tons, whereas the composite box cars acquired in 1919 weighed 23½ tons. The replacement of the all-wooden freight car by the composite and the steel car is shown in Fig. 2. Figure 3 shows the increase in the average carrying capacity of freight cars of the country and pictures the trend of increased light weight of cars as shown in the case of box cars.

These changes in the weight and capacity of the freight car have resulted in its increased punishment. Although freight cars have been greatly strengthened to meet the additional burdens placed upon them, and while there is really no disagreement throughout the country covering the strength requirement of these cars, the railroads do, however, continue to have bad order cars in great numbers. What is actually occurring is increased punishment to freight equipment because of the lack of cushion formerly provided in train movement by reason of the wooden car's disappearing. If operating methods are to proceed as in the past there is absolutely no question but what resilience will have to be furnished through the medium of a suitably designed draft rigging, or else we may expect distinct failure of parts following a progressive cycle, depending upon considerations of relative strength factors.

Furthermore, while the freight car as a whole has been designed and constructed to meet modern operation conditions, many of its parts are not equal to the tasks imposed. The draft gear seems to be about the weakest part of most cars, when, as aforementioned, it must be depended upon to lessen the punishment received by the car. Very little

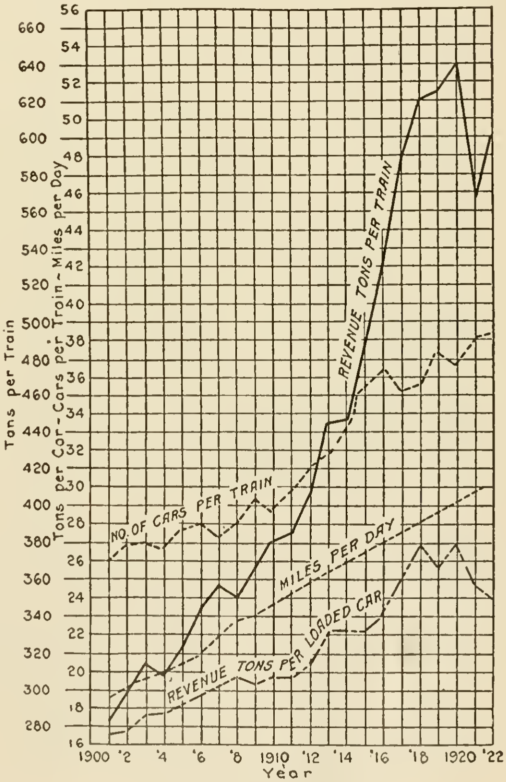


Fig. 1—Utilization of the Freight Car

has been done to improve the foundation brake rigging and air brake apparatus on the modern car as compared to the old unit, and yet experience shows that air brakes

*A Paper Presented Before the American Society of Mechanical Engineers.

are responsible for approximately one-fourth of the transportation delay to cars made in bad order in train yards and running repair tracks. Railroads cannot well continue accepting this kind of performance if they desire to keep the modern car in continuous service a maximum amount of time.

Importance of Design and Construction

The design and construction of freight cars was never of more importance than it is today. Each acquisition of new equipment should be made the subject of special study by the mechanical and transportation officials to determine, first the actual necessity for the cars, second the size and capacity which will give the greatest net returns to the company, and third the type of car. A thorough study of the design should be made before any cars are built. It is undoubtedly true that maintenance expenses are considerably increased due to failure to take everything into consideration when preparing the designs. The only way to insure that new cars when acquired will be a credit to the mechanical department, is to keep designs of each type constantly underway. Each detail must be critically analyzed and compared to existing types, and an endeavor made to eliminate its defects. A comparison of the final result with the original will usually show a surprising number of changes, and will convince anyone of the necessity of giving long and painstaking attention to every design.

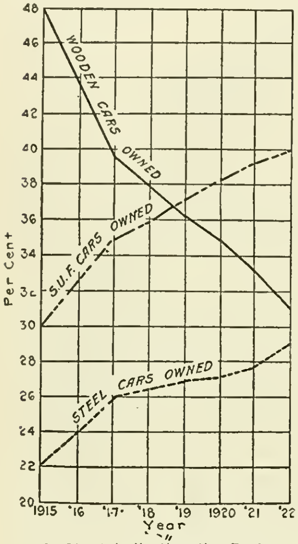


Fig. 2—Chart Indicating the Replacement of the Wooden Freight Car by the Composite (Steel Underframe) and All-Steel Car.

Few cars designed today can be criticized as lacking in strength in the essential parts, but it is also important that cars should be light so they can consistently be made easy to repair, and well protected against corrosion. Few cars meet all these requirements, and their failure to do so has led to severe criticism of car design from a maintenance and operating standpoint.

In the matter of designing and constructing a modern car, the details of material, as previously mentioned, cannot be judged entirely from the strength requirements. The question of deterioration over a period of years need to be given serious thought, because, for instance, if a roof become defective in one-half the time that the remainder of the principal portions of the car run before needing attention and has to be repaired, the car as a whole is held. This emphasizes the need of studying the parts in relation to their cycles of renewals, so that they may be grouped and the number of days they are detained on the repair tracks consequently reduced.

Deterioration of Cars

One of the greatest sources of deterioration of freight cars, irrespective of the material or construction, is corrosion or decay, which continuously exerts its destructive influence whether the equipment is in service or not. In the case of wood parts there are very few renewals which are not directly caused or at least greatly hastened by decay. A close analysis of failure which appear to be purely mechanical will generally disclose the gradual destruction of the piece by decay as the original source of weakness. The matter therefore of preventing the destruction of material by chemical action is case of metal and by the propagation and growth of the destroying fungi in the case of wood is worthy of considerable study.

A car must also be considered from the standpoint of items affected by friction or transportation such as wheels, brake shoes, draft rigging, couplers, and the truck as a whole. The wear and failure of these parts constantly increase with the greater utilization obtained from the modern car. To withstand this greater hardship it is essential that proper designs and proper material be employed in each case. The use of correct metals and alloys requires a more thorough study. Certainly we never should use a brittle steel for parts subject to great shocks, or soft iron for parts subject to much friction, yet this has been done, resulting in failures. Sills, framing members, etc., are subject to strains that in time wear them out.

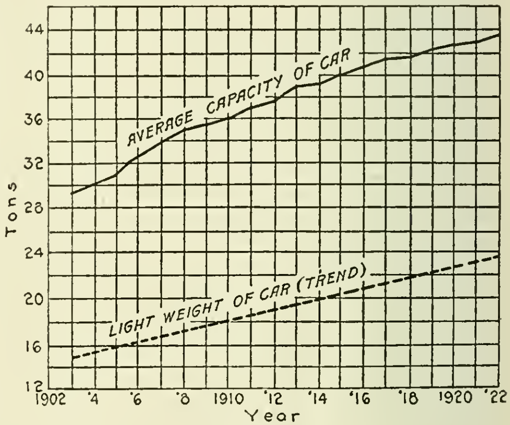


Fig. 3—Chart Showing Increase in Capacity and Light Weight of Freight Cars.

These parts must be of such construction that shocks and vibrations incident to the service will not impair their efficiency.

Consideration should be given to building cars strong enough to meet general requirements and yet so put together, materials and otherwise, as not to be unduly heavy. In other words, cars should be designed to have a high ratio of load to total weight. This is important because dead weight is a factor in train movement. A five-year average of the freight trains handled on one western road showed that for each net ton of revenue freight carried the train hauled 1.2 tons of dead weight exclusive of locomotive and tender. Approximately 66 per cent of the cars hauled were loaded. It is a well-known fact that automobile manufacturers have made successful attempts to reduce the weight of automobiles, yet retaining or increasing their loading capacity. Certainly this matter needs very serious study on the part of car designers.

It is not a good policy to materially sacrifice the design of a car to accommodate details. Standards, however, are unquestionably excellent. At the present time details that will absolutely interchange between all different cars are too few. As long as cars are built for some particular service we may expect to have a difference in construction due to the commodity to be transported. The present tendency is toward refinement in car design, and, if it continues, equipment built a few years hence will probably be radically different from what is considered standard practice today. Already a remarkable number and variety of new designs of cars have been introduced.

In the matter of maintaining freight cars it must be continually kept in mind that cars that can be kept in continuous service with a minimum cost of maintenance and which are sufficiently efficient to protect the lading in transit, mean dollars and cents to the railways. One road found that during a five-year period the cars on the line averaged between 25 to 56 days per year in bad order; also that frequency of repairs averaged between 22 to 34 times per year. In other words, a defect occurred for about every 500 miles the car moved.

Classes of Freight Car Repairs

Freight cars are subject to many defects which make them unfit to operate. Some are of little consequence; others require considerable time and labor to repair. In general freight car repairs are governed by frequent renewal of certain parts and infrequent renewal of other parts. They are roughly divided into two classes: lights and heavies. Light repairs consist of work done to offset current wear, breakages, and loss of parts accruing from ordinary handling and movements of cars day by day. Heavy repairs accrue, generally speaking from four different sources: wrecks, ordinary wear and tear as accumulated over a period of years, natural deterioration and obsolescence.

To a certain extent the problem of handling light repairs is readily dealt with; that is given reasonably adequate supplies of tools, material and standard parts, and a certain force of men, that part of the maintenance problem will take care of itself, and cars will be switched on and off of the rip track daily without much fluctuation. It has generally been found that six light repair cars are repaired during the day to every one left over at the end of the day, and it is this feature of the work which results mostly in an increase or decrease in the bad order car situation.

The situation with respect to heavy car repairs is entirely different. Repairs to cars due to wrecks and accumulated ordinary wear and tear are usually accomplished by replacements in kind, but more extensive work is required to overcome obsolescence as in this case it becomes necessary to strengthen and remodel the cars to overcome inherent weakness in design and construction. These cars remain a comparatively long time out of service and require a comparatively large expenditure to place them in proper condition. It is in the handling of heavy car repairs, therefore, that the greatest opportunities exist to produce economies and reduce the time that the cars are held out of service.

Age of Equipment and Frequency of Repairs

Studies made of maintenance policies and work done in repairs over long periods, particularly in relation to the life of equipment indicate that under conditions prevailing for the last 30 years freight cars have been given heavy repairs by owners on an average of once every eight years. In other words, at the end of the eighth year the car, if normally maintained in the meantime so far as wearing parts are concerned, would require heavy repairs which would again make it good for another cycle of about eight years; after which it would be again given heavy repairs for another eight years of service if found to be of proper design, or would run with a limit of repairs until worn out. In this case the life would be extended to approximately 24 years or more, with a few years added to the life of the car where it was permitted to run in some minor service entirely worn out. If at the end of the second cycle the car was found not worth repairing, it would be run about four years longer until worn out. In actual practice there is considerable variation of these figures, so that studies have developed that the average life of equipment has been approximately 20 years, particularly the body, there being a factor of safety required in the trucks which made them serviceable for about five years longer than the body. Practically all freight cars in the country have been depreciated on the basis of 20 years life for the body and 25 years for the trucks, as set up by the Interstate Commerce Commission for valuation purposes.

There is no specific record of the average frequency of rebuilding or heavy repair work by classes of cars. The general data indicate an average period between heavy repairs to box car of about nine years for those equipped with modern steel underframes, and about eight years for those with wooden underframes and relative construction. Modern refrigerator cars will require about seven years between heavy repairs because of the necessity of going over the insulating feature as well as overcoming structural deterioration. Stock cars will run about nine years due to their light construction. Coal cars will run from nine to ten years whether all-steel or composite. Steel floor sheets usually last about eight years and the side sheets about nine years, so that if false floor are used for a while the cars can be run about nine years. This has been the experience with the character of metal used in the past, which has been unable to withstand sulphuric acid coming from the coal.

The wisdom of having freight cars in good condition cannot be doubted and the expense of maintenance is justified, particularly where the general condition of equipment is such as to require heavy work to overcome what we might call "inherent obsolescence." In other words, where the proper cycle of heavy repairs as previously explained has not been maintained in due course, a certain extent, obsolescence, which must be overcome sooner or later.

In order to maintain a normal situation as to design, construction, and obsolescence, the average age of equipment should be carefully noted at all times, as this reflects whether or not old equipment is being retired as due and replaced with new or rebuilt equipment. It has been customary to assume an average life of 20 for freight cars. Assuming that a road has an ownership of 100,000 cars normally at all times, then from year to year it should retire or rebuild an average of 1/20 of 100,000 or 5,000 cars and should acquire new equipment each year equal to the number actually retired and not replaced with rebuilt equipment.

It will be noted that a road has the choice of two policies in maintaining its equipment to overcome inherent weaknesses. It can retain its equipment for a longer period by overhauling and improving existing cars, or it can retire and replace the cars with new equipment at a more rapid rate. The policy to be followed depends upon many considerations, such as finance, operating expenses, and the extent of obsolescence.

Freight Car Maintenance Appropriations

The matter of appropriations for freight car maintenance deserves special study. Operating revenues have many mouths to feed, and when heavy retrenchments in operating expenses become necessary it is to a certain extent inevitable that the maintenance departments bear more than their proportion of such retrenchments because maintenance work can be temporarily deferred without immediately destroying the effectiveness of the transportation machine. However, injudicious savings in maintenance result in actual loss to a road through increased transportation costs and heavier later costs to overcome deferred maintenance. The problem, therefore, is to be determined where economy ends and loss starts in the retrenchment of maintenance expenses. An ideal condition would be to have the repair work equalized over the twelve months' period by arbitrary charges against income in the months of great business for credit and use during periods of revenue depression.

It is costly to make repairs to cars without proper repair facilities and equipments, and conditions become worse as the weight and capacity of cars increase. It is, of course, out of the question to provide numerous costly machines and tools where only a few cars are handled, but some repair track that turn out as many as 100 cars a day have practically no equipment for expediting the work. The labor cost of repairs made on large repair tracks is usually much too high. Careful planning of major operations and the judicious expenditure for facilities will do much to correct this condition. This problem again is a financial one, and a road has the choice of three policies to pursue: first, resort to man power due to inadequate facilities; second, add a few machines or tools each month so as to gradually reduce the repair expenses, and third, spend a considerable sum to immediately equip the shops and repair track with the needed facilities.

Obviously the policy to be pursued will depend upon the road's finances, though no road can long afford to pursue the first policy for the lack of repair facilities decreases net earnings. Capital account expenditures cannot be made to better advantage at this time in any direction by the railroads than through provisions for modern repair shops and equipment. In the past the acount of money expended by the railroads for logical repair shop facilities has been lamentably out of proportion to the amount of money expended for cars and locomotives, resulting in inadequate facilities for needed repair and modernizing work. The conclusion is that every advance in the art of car design should be made with a corresponding advance in the facilities for maintenance.

There is every reason to believe that the traffic on railroads in this country will increase as rapidly in the future as it has in the past, and that the locomotives and cars will continue to grow larger. Bigger power is demanded at all times, and yet to haul a maximum train not only requires strengthening of freight cars, but roadways, bridges, roundhouses, shop facilities, and tools; and it must be remembered that when the freight cars are not used to the fullest degree they present a corresponding loss in all these elements, such as make these extreme and uneven developments oftentimes a poor net result.

Every freight car involves not only the cost of maintenance, but interest on the investment and current depreciation charges, both factors now being higher because of increased investment cost. The object of the design of cars, and the installation of facilities to make the maintenance cost relatively low, should be to increase the days of service by decreasing the days of detention in bad order because the greatest present-day cost of maintenance, interest and depreciation charges imposes upon proper railway management a greater availability for constant use.

Early History of the 4-6-2 or Pacific Type Locomotives

By W. E. SYMONS

In the development of American railways, engineering skill and inventive genius have played a most conspicuous part and to those who have contributed to our great achievements we should be unstinted in our praise, while to those whose ideas have wholly or partially failed in adoption we should be most charitable.

In the field of locomotive design we find a willingness to accept credit for the first or original design of any particular type of engine that has proved to be "a winner" as it were, while there is a corresponding desire to disavow responsibility for any of the "off color" or freak designs that were short lived or of odious memory.

In a search of authentic records as to date of design and construction of the first Pacific type engine it appears that the credit is due the officers of the New Zealand Government Railways for original design, and the Baldwin Locomotive Works for the construction of 13 engines of this type which were built on orders of Mr. T. Romayne, general manager, dated February 28, 1901, and were completed and shipped from Philadelphia in July, 1901.

These engines were referred to in the order for their construction, as 10 wheelers with trailing wheel under the Wootten firebox and with cabs at back end of boilers as in other 10 wheelers built for that company.

Missouri Pacific Engines in 1902

In 1902, or about one year later than the construction of the New Zealand engines, the American Locomotive Company built for the Missouri Pacific Railway Co. engines of the 4-6-2 type and the word Pacific as a type designation was suggested as one of contradistinction between this type and its predecessor, the Atlantic, as well as by the fact it was built for a Pacific railway.

So that it would appear from the foregoing that the record might read as follows:

A—The first 4-6-2 locomotives built in this country were constructed by the Baldwin Locomotive Works for New Zealand Government Railways, and were designated 10 wheelers with trailing wheel to support Wootten firebox. Ordered February 28, 1901. Shipped July, 1901.

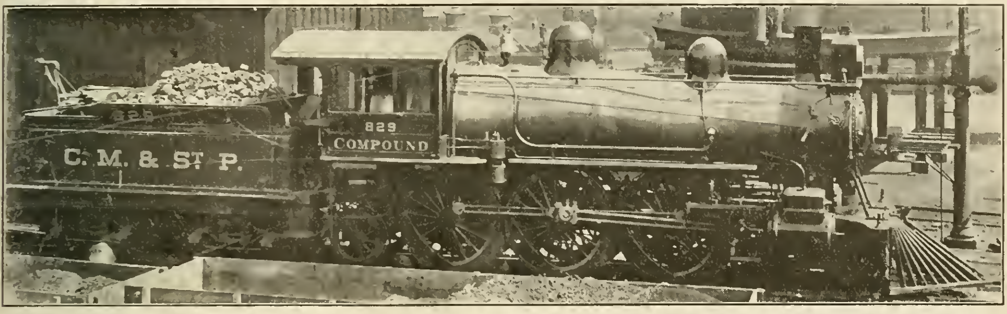
B—The American Locomotive Company built for the Missouri Pacific Railway in 1902, 4-6-2 locomotives, and designated them for the first time as Pacific type.

Thus, the birth and christening of the 4-6-2 or Pacific type was definitely fixed as 1901 and 1902. But here comes a feature of the question of priority, which prompted Mark Twain to suggest that the reports of his death were very much exaggerated.

St. Paul's 4-6-2 or Pacific Type Engine Designed in 1892

For many months prior to opening the World's Columbian Exposition in Chicago in 1893, the railways entering that city made great preparation for handling the increased volume of business, and the locomotive builders vied with each other in their effort to display samples of their modern up-to-date locomotives. In order to successfully handle their heavy fast passenger world's fair trains between Chicago and Milwaukee, the St. Paul ordered in 1892, from the Rhode Island Locomotive Works, and had delivered to them early in 1893, three 4-6-2 cross compound locomotives, that were at that time the admiration and envy of many. One of these (at that time famous engines) No. 830 was on exhibition at the world's fair and attracted much attention, and, according to records of that period they were designated as ten (10) wheel engines with a trailing wheel.

These engines weighed 150,000 lbs. distributed as follows: Front truck, 41,000; driving wheels, 90,000, and trailing wheels, 19,000, from which it is clear that the trailing wheel was not applied for the purpose of supporting a wide overhanging firebox as in the present Pacific type,

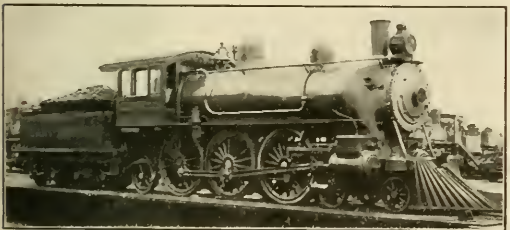


Original 4-6-2 Type Compound Locomotive Built by Rogers Locomotive Works for Chicago, Milwaukee & St. Paul Railway

but obviously from the belief that 109,000 should not all be supported on so short a rigid wheel base.

It may also be mentioned that these engines had what was known as a pocket firebox 120 x 33¼ ins., or about 26 square feet of grate area which was one of the defects in the design.

Nevertheless, the first three members of the Pacific type family, sometimes referred to as the triplets, were conceived in 1892 and born in 1893—the actual christening or introduction of the name "Pacific" as a type, however, as above stated, occurred in 1902 or 10 years later.



4-6-2 Type Simplified and as Used on Plant System

History of the First 4-6-2 Engines

The cross compound 4-6-2 engines did not fully meet the expectations of either the builders or the officers of the St. Paul Railway in service, and after various modifications such as changing from cross compound to single expansion, increasing boiler pressure and removing trailer wheels, thus making a straight 10 wheeler in order to increase their tractive capacity, still they did not prove satisfactory, and were finally returned to the builders at Providence, Rhode Island.

Plant System Bought Triplets in 1900

In 1900 the Plant System of railways was in bad straits for power to move an unusual volume of business, and while new engines were on order, deliveries were months away, and in this emergency the triplets, although not considered of good design, were purchased, as single expansion 4-6-2 engines and placed in service handling passenger trains between Savannah, Ga., and Jacksonville, Fla., where with good fuel and under favorable conditions they rendered very good service, although of limited grate area and with defective steam distribution due to a faulty design of valve gear (with 120 inch link radius), which made it necessary to redesign, using an intermediate transmission bar with a link radius of about 47 inches.

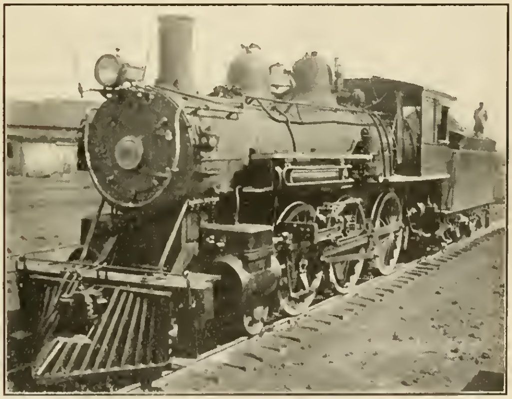
Illustrations of the triplets at the three periods of their history are here shown:

Fig. 1—Birth of the 4-6-2 or Pacific type, 32 years ago. As cross compound, ten wheelers with trailing wheel to distribute weight and make engine easier on track.

Fig. 2—Bought by the Plant System in 1900 as single expansion 4-6-2 type.

Fig. 3—As now in service on Atlantic Coast Line Railway as plain single expansion 10 wheelers.

It would appear from the above that the first 4-6-2 engines came into existence through placing a trailing wheel under rear of 4-6-0 or standard 10 wheel engine, in order to relieve the superstructure or track load and as this left the drivers limited in adhesive weight, the trailers were



As Now in Service on Atlantic Coast Line as a 4-6-0 Type

removed (or rejected) in order to improve their performance.

Depreciation and Average Life

As a fundamental principle the depreciation charges, taken up monthly in operating expenses, should cease, "when such charges with respect to any equipment, plus the scrap value, equals the ledger value of the property."

The rate or amount of depreciation varies with different railway companies from as low as 2 to above 4 per cent, the average being above 3 per cent, on which basis the normal average life of a steam locomotive would be about 30 years depending, of course, largely on the standard of maintenance.

It does not often happen that in the ordinary span of business or social life one might ride behind the same locomotive on two different trunk lines, more than 1,000 miles apart, and with an interim of 32 years, and with the engine good for possibly 10 to 15 years' more service.

If anyone who rode on the St. Paul's crack world's fair passenger trains between Milwaukee and Chicago in 1893, that was handled by the Rhode Island 4-6-2 cross-compounds, will now ride on passenger trains 9 and 10, between Jacksonville and Ocala, Florida, on the Atlantic Coast Line, they will have enjoyed this rather unique experience.

The Turning of Driving Wheels

The present day wheel lathe is a very heavy and stalwart machine and is capable of taking a heavy cut with a big feed, and moreover standing for a good deal of excess stress. But that is no reason why it should be abused as it very often is.

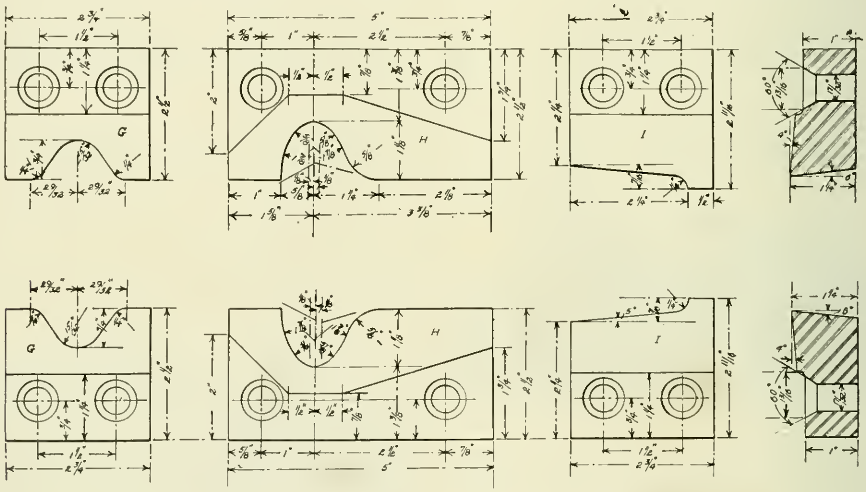
It was built for taking an ordinary roughing cut of sufficient depth to do all of the work with one cut, leaving merely the rough surface left by the tool to be smoothed off for the finished wheel.

It frequently happens, however, that the finishing tool is all that is used. This is an abuse both of the cutting tool and the machine. A shaped finishing tool is a costly piece of steel after the work has been done upon it, and it is not fitted or suited for cutting through the hardened cold-rolled surface of a worn steel tire. Yet it is frequently driven straight in, cutting off the high spots at first and finally cutting over the whole surface of the tread and flange.

Besides a rapid dulling and wearing of the tool, this puts an undue strain upon the tool posts and driving mechanism of the lathe. And, then, when this supposedly short cut on the job has been finished it will be found to have taken more time and left a poorer example of workmanship than if it had been done as it should have been in the first place.

As a protest against such a willful abuse of tools and machinery and as a guide to the proper method for those who know no better the William Sellers Co. of Philadelphia have had a drawing made embodying the complete dimensions of the cutting tools to be used and the method of using them, a drawing that is here reproduced.

There are four cutting tools in all, each of which are made in rights and lefts for the right and left hand turrets respectively. The first which is not shown in a special drawing is the roughing tool F. Then there are the three finishing tools, G, H and I, with the corresponding mating tools marked with a prime. Of these the upper row is for the left hand turret and the lower row for the right hand turret. The cutting edges of each tool has a rake of 4 degrees and a clearance of 6 degrees, which has been found to give the best results for finishing work in tire steel.



Details of Cutting Tools for Turning of Driving Wheels

The complete dimensions of each piece are given so that it may be readily reproduced in any tool room, with the possible exception of the countersunk holes for the fastening bolts which must be spaced to match the holders.

The method of using the tools is illustrated by a special drawing.

In the upper part marked *A,* we have the contour of a worn tread and sharp flange shown by a full line, and the contour of the standard tread and flange shown by a dotted line by which the amount of metal to be turned off in order to obtain a full flange is visualized. From this it appears that nearly ½ in. must be turned off of a portion of the tread and about ⅜ in. from the top of the flange in this particular case.

The drawing *B* shows the accomplishment of the first step by the roughing tool *F.* In this the full line represents the contour of the tread and flange after the roughing cut has been taken, and the dotted line shows the contour of the original worn tread and flange. The space between the two represents the metal removed by the roughing tool.

Attention is called here to the point to which the roughing tool has been driven. It has been fed up to the point of final finished contour of the throat of the flange.

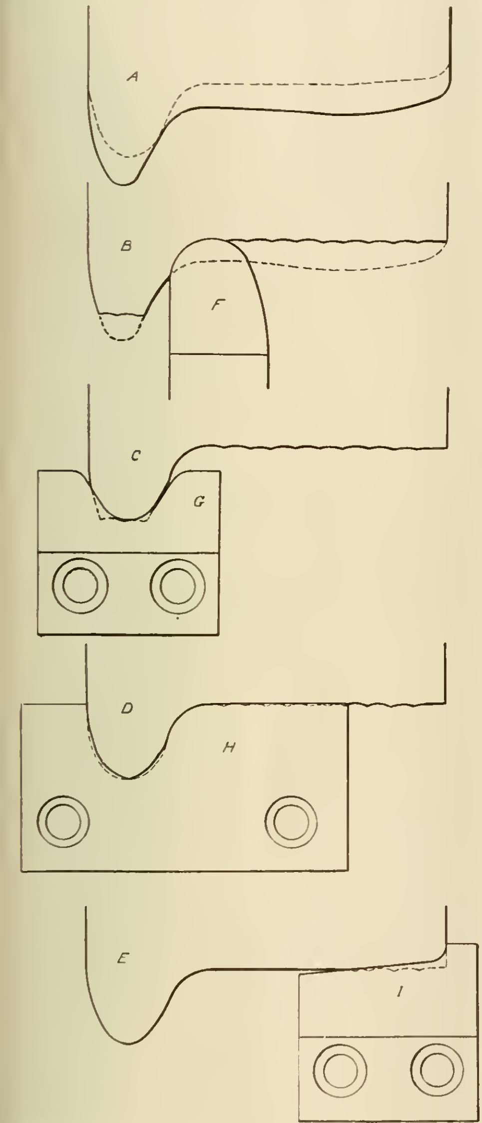


Illustration of Method of Using Cutting Tools in Turning Driving Wheels

After this first roughing out the contour of the flange presents two sharp angles. These are cut off by the tool G which is fed straight in, cutting off the part represented by the dotted lines in stretch *C* and leaving the tread and flange in the shape shown by the full lines.

Next in the sketch *D* the tool *H* is brought into play. The contour of the tread and flange as left by the tool *G* is shown by the dotted line, and the finished tread and flange after the cutting of the tool H by the full line. It will be seen that this tool *H*, which is the main finishing tool and which is the most expensive of the set to make, is called upon to remove scarcely more than 1/32 in. of metal.

Finally the outside taper of the tread is formed by the tool *I*, which is fed in and has to remove the small amount of metal shown by the dotted line in the sketch *E*.

By this method the finishing tools are required only to remove the small roughness left by the coarse feed of the roughing tool, and the work done is well within their intended capacity.

The tools here shown are shaped to turn the American Ry. Assn. standard flange with a cylindrical tread and a single taper on the outer edge of 5 degrees, with the cross slides set at right angles with the line of lathe centers.

By modifying the shapes and setting the cross slides at an angle with the line of lathe centers, other flanges and conical treads can be produced.

The point to be emphasized is that with this method using such tools the work can be done in the minimum of time, with the use of the minimum amount of power, a minimum of wear on the cutting tools and a minimum of stress on the lathe.

Pennsylvania's New Heavy Eight Wheel Switcher

An eight wheel switching locomotive of entirely new design has just been completed and turned out of the Pennsylvania Railroad's Juniata Shops at Altoona, Pa. This locomotive, known as "Class C-1," is the first to be delivered on an order for 50 placed with the Altoona Works several months ago.

The new type "C-1" switching locomotive was designed and built to meet a growing need for more powerful engines of this type at terminal points and hump yards where heavy freight trains are shifted and classified. The operation of heavier freight trains, made possible by the use of more powerful road freight engines, necessitates a stronger and heavier switching engine for the work of breaking up and remaking these trains in yards and terminals.

The class "C-1" locomotive has cylinders 27 in. in diameter by 30 in. stroke; driving wheels 56 in. in diameter, and steam pressure of 250 pounds per square inch. The weight of the locomotive in working order is 275,000 pounds. The tractive force is 76,000 pounds.

The 50 locomotives to be turned out on the present order will be distributed to various points on the System where traffic is of such nature as to require a switching engine of this power.

New Cars Installed Total Nearly 400,000

Since January 1, 1923, according to the American Railway Association, 398,442 new freight cars were installed by the railroads, to enable them to keep pace with the industrial development of the country. In the first three months this year 44,153 cars were installed.

On April 1, freight cars on order totaled 46,126.

The railroads also placed in service during the first three months this year 430 locomotives, which made a total of 6,713 installed since January 1, 1923. Locomotives on order on April 1 totaled 315.

The average tractive power of locomotives on April 1, 1925, was 40,048 pounds, an increase of 1.5 per cent over that for April 1 last year and an increase of 7.0 per cent over two years ago.

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The Frequency of Locomotive Shopping

The paper read by Mr. Sillcox at the spring meeting of the American Society of Mechanical Engineers, an abstract of which is published in another column, suggests a new line of action in the shopping of locomotives. He very carefully denies that the method of infrequent shopping which has been found to effect such a notable saving on the Chicago, Milwaukee & St. Paul Ry. is the best or even that it would be applicable on other roads where the operating conditions were different. In fact all through the paper he emphasizes the fact that the local conditions of grades, curves, density of traffic and character of the motive power must be carefully considered in the adoption of any shopping plan.

The decrease in what would be the normal frequency of shopping is not altogether a new idea but that decrease has usually been due to a lack of back shop facilities that necessitated the loading of the round-houses with more or less of the heavy repairs. It was confessedly an uneconomical proceeding because of the lack of proper facilities to do the work assigned. Thus we have found tire replacements made in the open air without unwheeling the engine; and rod, motion and driver box work undertaken with no conveniences at all. It was simply a case where the master mechanic was driven to the wall to keep his power in operative condition.

Mr. Sillcox has approached the problem from quite another angle. He has recognized that the locomotive is not a one-horse shay, that will run a hundred years to a day, and then because every part is as strong as the rest it simply suddenly crumbles to dust. So instead of loading his back shop with minor repairs he has increased his round-house facilities, so that they are capable of making these repairs at no more cost than when done in the back shop.

The probable result is that he has only done that which was actually required and not, "because the engine is in the shop," given it the thorough overhauling which was not really needed.

The wear and tear of the motion work is more rapid than other parts of the engine and needs more frequent attention, so that it can be readily understood now, if this is kept up, the frequency of back shopping may well be cut in two.

Rod, box, guide, crosshead and tire work, can be done individually with but a small increase over ordinary turning delays, while if done as a whole, the delay occasioned by doing the work in a well-equipped roundhouse, will be far less than if the engine were to be put into the back shop for the work.

It was one of those things that, attempted with a faint heart or with half-way measures, would have shown losses instead of savings. Hence, to avoid any such mischance the ground was carefully studied and analyzed, always with a view to the local conditions of the road. And this analysis having shown that there would be a saving by a change of policy as to the frequency of shopping, and the allocation of certain repairs to the roundhouse, the plunge was taken. The roundhouses were suitably equipped and the results have justified the judgment that decided upon the change.

In setting forth the accomplishments Mr. Sillcox does not claim all of the apparent savings for the change of policy, but gives due credit to the difference in unit costs between those prevailing before and after the change was instituted. But even after a most liberal allowance for these differences it is apparent that the change has been a most profitable one for the road.

As to whether others will have the courage of their convictions, or can convey their convictions to the holders of the purse strings, remains to be seen. Certainly if the experience here set forth is of any value, the lead is well worthy of a large following.

Technical Knowledge vs. Business Ability

"Steam Railroad Electrifications from the Executive Standpoint," was the subject for discussion at the annual meeting of the American Institute of Electrical Engineers, which was held in New York on May 15th. Contributions to the discussion were made by prominent railway officers, manufacturers of electrical equipment, and Secretary of Commerce Herbert Hoover and one of his aides, Mr. Paul Spencer Clapp. In stating his views, Secretary Hoover said:

"The people of the nation have a great and vital interest in this problem. Such plans, if wisely laid, will considerably shorten the time until the benefits of increase in transportation facilities from electrification can be enjoyed. Standardization, at least of the fundamentals, will facilitate the development of a coordinated electrified transportation system, which will give a maximum of service with the best utilization of capital and labor.

"Failure to accomplish the preliminary standardization will result in enormous losses, which must reflect themselves in larger cost for transportation and in a reduced service. The standardization of electric transport equipment will insure interchangeability of equipment, better utilization of locomotives and freight equipment. It will lower cost of manufacturing, reduce repair stocks and enhance the efficiency of operation. Uniformity in voltages, frequency, and other electrical characteristics will permit of much more effective application of electric power."

In his remarks, Mr. Paul Spencer Clapp stated that the problem of electrifying the railroads had reached a stage where it is necessary for the immediate standardization of electrical equipment. He pointed out the loss that would come through diversity of systems and added that to restrict the operations of locomotives was not good for national defense, to say nothing of the detriment to commerce and industry. Gerard Swope and E. M. Herr, presidents of two of the largest manufactories of electrical machinery used in railway transportation, each spoke in favor of electrification of railways, the former pointing out. "That if only one-half of the railway mileage were electrified that the saving in fuel alone would be about $120,000,000 per year," while the latter not only urged electrification, but spoke of the more favorable attitude of the public in general toward railways.

C. H. Markham, president of the Illinois Central Railway, which company has in hand electrification of its terminals in Chicago, involving as it does the expenditure of many millions of dollars for which the company is responsible to the owners, suggested caution in reaching a conclusion on a matter of such vital importance as electrification, and that the feasibility of any plan should be considered from a practical standpoint rather than its theoretic features.

Robert J. Cary, general counsel of the New York Central, although disclaiming any knowledge of electrical engineering or of railway operation, drove home some good hard and pertinent facts that all those who have to do with the electrification of steam railways may well study, and should be prepared to fully answer to a jury of experts who are not in any way interested in the manufacturing or sale of prime movers used in railway transportation, before taking definite steps in a matter involving the expenditure of such great sums of other people's money.

We are living in an age of progress, hitherto unknown in the world's history, in which electricity has, and will play a conspicuous part, and we most cordially endorse its use when, and wherever it has been fully demonstrated by neutral experts to be the most suitable form of prime mover both from an engineering, operating and financial standpoint.

In reviewing the numerous presentations of this important question of electrifying steam railways by our most prominent electric engineers, we find much ground to justify Mr. Cary's comment on the lack of uniformity or agreement among electric engineers themselves as to any definite specifications, rule or convention, either for general use or for any specific steam railway, the application of which can be relied on as a remedy or cure for the ills complained of, even to the final analysis of exactly what will be the effect on the shareholders' dollar.

Railway statistics in recent years have led us into the use of large figures, where we formerly talked in terms of hundreds and thousands, we now use millions and billions of dollars. When it is suggested that by electrifying only one-half of our steam railways there would be a saving of approximately $120,000,000 per year on fuel alone, plus other financial and material advantages, the average mind inquires: "What is the matter with our railway managers? Are they unprogressive, or stupid or both?" No, they are neither. They are not only progressive, but as business men weigh carefully all angles of such propositions. They well know that as a prerequisite to the economies expressed in millions, that they must first go out and procure not millions, but billions of new capital, thus adding to the burden of fixed charges, already too high, and thereby creating a much more inflexible and expensive transportation unit to handle the same, and possibly a less volume of business, while the public are constantly clamoring for lower rates.

The answer of our progressive railway managements to this question, we think may be found in the cautionary suggestions of those who have carefully analyzed not only the operating features and economies resulting therefrom, but the present and probable effect on their financial status.

We believe that electrification of steam railways will progress just as fast as it is found to be "A Good Sound Business Proposition."

The Duties and Responsibilities of Railroad Mechanical Organizations

At the April meeting of the Western Railway Club, Mr. A. G. Pack, chief inspector of the Bureau of Locomotive Inspection, read a paper on the above subject. In the course of his paper he presented some striking statistics regarding the prevalence and cost of railroad accidents.

During the last 25 years records show that there were 218,830 persons killed and 3,308,935 others injured on the railroads, from all causes, or an average of 1 person killed every hour and 1 injured every 3 minutes and 57 seconds. Of this number, 75,684 were employees killed and 2,809,592 were employees injured while in line of duty, or an average of 1 killed every 2 hours and 54 minutes and 1 injured every 4 minutes and 36 seconds.

During the calendar year 1923, 7,385 persons were killed and 171,712 others injured, or an average of 1 killed every hour and 3 minutes and 1 injured every 3 minutes. Of this number 2,002 were employees killed and 152,218 others injured, while in line of duty, or an average of 1 killed every 4 hours and 27 minutes, and 1 injured every 3 minutes and 27 seconds.

The 75,684 employees killed and 2,809,592 injured during the 25 year period are more than twice the number of American soldiers killed and more than fourteen times the number wounded in battle during the great world war.

During the last 20 years derailments caused a loss of $171,943,014; $8,597,150 per year; $716,430 per month, or $23,554 per day. During this period collisions caused a loss of $173,717,858; $8,685,393 per year; $723,781 per month, or $24,453 per day—a total loss of $345,650,872 during this period, or an average of about $48,007 per day. The data covering separately the damages resulting from locomotive accidents is not available for a twenty year period. However, during the last 8 years the loss resulting from accidents to locomotives has averaged more than one-half million dollars per year. These figures do not include damage paid by the carriers on claims arising from such accidents, the amount of which cannot be estimated, but would probably equal the damage to property.

Let us consider what is involved in the maintenance of the locomotives on the railroads of the United States. There are at this time approximately 70,700 steam locomotives which represent an increase of about 40 per cent in number in the past 20 years, while the tractive effort has increased about 140 per cent. It has been variously stated that the value of locomotives on the railroads in the United States is approximately 60 per cent of the total value of all the machinery, implements and tools used in all of the other industries of the nation. During the year 1923 the railroads spent for locomotive repairs $559,280,737—for fuel about $529,219,236. There were about 550,000 people employed in the maintenance of equipment and stores on the railroads.

When the responsibility for the directing of these expenditures is considered it is not too much to suggest that the directing officer of the mechanical organization be given full authority over his organization and expenditures, at least authority equal to that of the chief operating officer, and held strictly responsible for the results. It is for the transportation officials to make the specifications—it is for the mechanical department to fill these specifications. It is for the transportation department to advise of the character and volume of traffic to be moved; it is for the mechanical department to furnish power for moving that traffic according to the specifications laid down. The mechanical department knows better than any other the capacity and the physical condition of every locomotive on its line and knows where it can serve to the best advantage after the requirements of the transportation department are made known. The motive power must be ready and capable of delivering the traffic at its destination on scheduled time or the whole operation of a railroad is interfered with.

And the possibility of meeting these requirements depends upon the condition of the locomotives, and a few cents per mile added to the cost of necessary locomotive maintenance is more than compensated for, by the reduced cost of transportation.

There is nothing which so adversely affects the proper and economical maintenance of equipment as to disrupt the mechanical organizations at frequent intervals, or to fluctuate its personnel with every temporary fluctuation in traffic. Equipment can not be properly and economically maintained if repairs are neglected until the busy season comes. It is then that it should be in revenue service and not in the shop. It is then that the transportation department is pressing for motive power and the shippers are clamoring for cars, therefore, in keeping with good sound business principle, it should be repaired during dull periods and be available when the rush comes. To which must be added the discontent that arises from irregularity of employment, and there can be no doubt that better results will be obtained and savings effected if the mechanical organizations can be stabilized and have their appropriations for betterment and labor fixed in advance for a period of not less than one year, to be expended in approximately equal allotments throughout the year so that a definite plan may be followed. I appreciate that revenue cannot be disregarded in making expenditures, but with careful consideration and foresight, it seems that they can be anticipated with sufficient accuracy to provide more uniform employment and practices with respect to maintenance of locomotives. The required amount of money must be provided and must be spent during the year whether spasmodically or uniformly.

A single instance will afford a good example of what can be accomplished along these lines.

Some time ago, in order to avoid taking punitive measurements against a large railroad system operating more than 2,000 locomotives, I called upon the president and called his attention to the condition in which locomotives were being operated and some of the causes therefor, which were the failure to provide sufficient material, material of inferior quality being used, roundhouses undermanned, shops under-manned or closed at a time when they should be operating at full capacity.

When I had finished my statement he turned to the superintendent of motive power and said that from that time on he would have sufficient money provided and would expect that the conditions would be immediately improved, but that he was going to hold him strictly responsible for the results.

In 1920 this company had 621 engine failures due to leaky flues and made 84,740 engine miles per failure from this cause. In 1923, the number of engine failures had been reduced to 130 and the miles per engine failure from this cause had been increased to 412,529. During 1924, there were reported 47 engine failures and miles run per engine failure were 1,620,910.

It is, of course, impossible to estimate the actual savings effected by these improvements because of the impossibility of estimating the real cost of an engine failure.

$750,000,000 for Equipment and Improvements

New equipment, and other capital improvements are expected to cost Class I carriers about $750,000,000 in 1925. This estimate was contained in a report recently submitted by the Bureau of Railway Economics to the American Railway Association in its spring meeting at the Blackstone Hotel, Chicago.

During the first three months in 1925 capital expenditures for additions and improvements to railway property of Class I carriers, amounted to approximately $662,322,000 including carry-over from 1924. Of that amount, $157,469,000 was actually expended during the first quarter of this year, leaving more than $504,850,000 to be spent later. Class I railroads, during the first three months in 1924, authorized capital expenditures for similar purposes amounting to $765,177,000, of which amount $188,374,000 was actually expended during the first three months of that year.

Considerable saving resulted from greater efficiency in the use of fuel consumed by the railroads. In the freight service, the number of pounds of fuel consumed per thousand gross ton miles was 170 pounds in 1924, which was a reduction of nearly 14 per cent compared with 1920 and seven per cent compared with 1923. Based on the freight traffic actually handled in 1924 and the prevailing fuel price in that year, the actual economy in fuel consumption in 1924, growing solely out of increased efficiency in use, compared with 1920 was 12,878,568 tons, while the money saving was $39,022,000.

In the passenger service, fuel consumption for hauling a passenger car one mile amounted to 17 pounds in 1924 compared with 18.8 pounds in 1920 or a reduction of nearly ten per cent. In 1923, it was 18.1 pounds. This reduction in 1924 was equivalent to a saving of 3,268,829 tons compared with 1920, a money saving of $9,905,000.

Selected train service costs have declined progressively since 1920. The saving in freight service costs alone in 1924 compared with 1923 was equivalent, on the basis of the freight traffic handled in 1924, to $124,016,000. The saving in the passenger service in 1924 was $40,387,000.

A very large part of the benefits resulting from increased economies in operation have been passed along to the public in the shape of reduced freight rates, there having been an aggregate reduction of $1,611,000,000 in freight charges during the years 1922, 1923 and 1924. This is the amount which shippers would have paid for transportation service in those years above what they did pay had the rates remained at the peak of 1921. In 1924 alone, the saving to the shipping public due to the reduced rates amounted to $618,000,000 compared with 1921.

The railroads have been supplying adequate transportation service to the commerce of the United States, but for this adequate service the compensation of the carriers has been and continues to be far from adequate. For the first three months in 1925, the rates of return on property investment was 4.48 per cent compared with 4.61 per cent during the same period last year. On this basis of tentative valuation, it was at the rate of 5.21 per cent during the first quarter this year compared with 5.33 per cent last year. These returns are shown on the basis of the property investment of the carriers which is the book value of their road and equipment, with working capital and supplies and cash; also on the basis of the "tentative valuation" of railway property fixed by the Interstate Commerce Commission as of the end of 1919, plus net addition from that date. The actual returns of the carriers by neither method have equalled the "fair return" as fixed by the Interstate Commerce Commission at 5¾ per cent.

International Railway Fuel Association Convention

Papers and Discussions Cover Every Phase of Railroad Operation Relating to Fuel Conservation

The seventeenth annual convention of the International Railway Fuel Association, which was held at the Hotel Sherman, Chicago, May 26-29 inclusive, was one of the most successful in the history of the organization. Aside from the valuable papers and committee reports, the program included addresses by prominent railway officers, including L. F. Loree, president, Delaware & Hudson Company; A. R. Ayers, assistant general manager, New York, Chicago & St. Louis R. R.; H. C. Pearce, director purchases and stores, Chesapeake & Ohio R. R.; and John Purcell, assistant to vice-president, Atchison, Topeka & Santa Fe Railway. The president of the association, P. E. Bast, Fuel Engineer, Delaware & Hudson Company, presided.

Mr. Loree's address was a feature of the opening session. In it he gave an outline of the development of the steam locomotive, predicting for the immediate future some very interesting improvements in locomotive design and construction. He said in part: "I have thought it might interest you if, for a moment, we try to forecast the future from this angle of inspection.

"In 1915 the typical large freight locomotive of The Delaware & Hudson was its Class E-5 of the consolidation type, using saturated steam, slide valves and single expansion cylinders, carrying 210 lb. boiler pressure, weighing 227,200 lb. on driving wheels, and rated at 50,600 lb. tractive force. In moving 1,000 actual gross ton-miles, including its own weight, on a 0.5 per cent grade, at average freight train speeds, this locomotive consumed 160 lb. of coal. The first marked improvement was the application of superheaters and the substitution of piston valves for the slide valves, increasing the weight of the engine on the driving wheels to 231,700 lb., and the tractive force to 55,100 lb., and reducing the fuel consumption under like operating conditions to 130 lb. of coal, or by about 19 per cent.

"Last year we developed a type of consolidation locomotive, changing the E-5 class as little as was necessary, which we named the "Horatio Allen." This locomotive carries 350 lb. boiler pressure, weighs 298,500 lb. on the driving wheels and has developed 75,000 lb. drawbar pull, as measured by the dynamometer. It uses a moderate degree of superheated steam admitted to and exhausted from the multiple expansion cylinders through large valve and port openings. It has a water tube type of firebox with extraordinarily large evaporation surface and a fire brick baffle wall extending the full width and length of the firebox which insures full utilization of the hand fired coal, with long flame travel, securing maximum radiant heat effect and minimum cinder and stack losses. With this engine 1,000 actual gross tons are moved under like operating conditions with 55 lb. coal consumption.

"Looking over the score of years from 1915 to 1935, the following changes may be anticipated during the next ten years:

Typical Steam Locomotive Coal Consumption per 1,000 Actual Freight Train Gross Ton-Miles on Equivalent to A 0.5 Per Cent Grade.

Year 1915 .... 160 lb.

Reduction in total fuel consumption by means of

1. Superheating ....to 130 lb.
2. Fire brick baffle wall...................to 124 lb.
3. Feed water heating ....to 113 lb.
4. 350 lb. boiler pressure..................to 96 lb.
5. Improved boiler design, circulation and evaporation ....to 84 lb.
6. Multiple expansion cylinders ....to 70 lb.
7. Improved steam distribution and reduced cylinder back pressure ....to 60 lb.
8. Burning powdered coal in suspension.....to 44 lb.
9. Reheating of high pressure exhaust steam in multiple expansion ....to 42 lb.
10. Miscellaneous items, such as increased train loading through the use of an auxiliary locomotive, utilizing the dead weight of the tender for tractive purposes, greater sustained boiler horsepower capacity, substitution of poppet valves for piston or slide valves, and higher superheat on account of the use of powdered coal, may bring the final figure down to about.... 38 lb.

"This is somewhat less than one-quarter of the 1915 locomotive fuel consumption. The effect of this would be to reduce the 90,000,000 tons of fuel now used in freight train service to about 27,000,000 tons, effecting a total economy of something like $200,000,000 per annum."

On the second day of the convention A. R. Ayers, assistant general manager, New York, Chicago & St. Louis R. R., presented a paper on "How Can Railroad Management Effect Fuel Economy." H. C. Pearce, director of purchases and stores, Chesapeake & Ohio R. R., then presented a paper on "How Can Fuel Purchases Effect Fuel Economy." A paper on "The Development of Oil Burning Practices on Locomotives" was then presented by J. N. Clark, chief fuel supervisor, Southern Pacific Co. The remainder of the morning session was devoted to a paper on "Fundamental Fuel Factors" by G. M. Basford and to topical discussion of "Effect on Fuel Consumption of Recent Developments in Operating Practices."

The sessions of the convention on the third day were devoted to subjects primarily of interest to mechanical department officers. John Purcell, assistant to vice-president, Atchison, Topeka & Santa Fe Ry., presented a paper on "How Can a Chief Mechanical Officer Effect Fuel Economy." This was followed by reports of the committees on feed water heating, by E. E. Chapman, chairman, engineer of tests, Atchison, Topeka & Santa Fe Ry., and the report of committee on front ends, grates and ashpans, Professor E. E. Schmidt, chairman, professor of railway engineering, University of Illinois, and to topical discussion of the reports submitted.

In this issue we publish the paper by G. M. Basford, entitled, "Fundamental Fuel Factors," and the committee's report on front ends, grates and ashpans. Abstracts of the more important papers and committee reports will appear in later issues.

At the concluding session of the convention, Chicago was selected as the place for next year's meeting and the following officers were elected for the years 1925-1926:

President, J. W. Dodge, transportation inspector, Illinois Central R. R.; Vice-Presidents, E. E. Chapman, engineer of tests, Atchison, Topeka & Santa Fe Ry.; J. E. Davenport, superintendent of fuel and locomotive performance, New York Central Lines; W. J. Tapp, fuel supervisor, Denver & Rio Grande Western Ry.; Secretary-Treasurer, J. B. Hutchison, Railway Educational Bureau, 1809 Capitol Ave., Omaha, Neb.

Fundamental Fuel Factors*

By G. M. BASFORD

An hour saved in 100-mile freight runs involving 20 freight trains per day saves $190,000 per year.

Assuming 100 miles of uniform one per cent grade, and 10,000 tons to be moved up this grade per day, it is found that, by decreasing tonnage so that average speed can be increased from 10 miles an hour to 17 miles an hour, a saving of over 5 per cent in cost of operation can be effected. If this increased speed is obtained by locomotives sufficiently powerful to maintain the tonnage, spectacular savings are available.

Getting in under the overtime limit, with heavier tonnage is like opening a gold mine.

A single brief stop involving a single train may cost as little as $5.00.

Vast possibilities of fuel conservation are suggested in these figures.

Ours is the era of railway operating improvement. Since 1830 it has been on its way. Under leadership of Mr. R. H. Aishton record service has been rendered with power and cars to spare, reassuring railroad owners, disarming politicians, transforming shippers into friends. Now come questions of growth, of adequate service with economical operation, questions of intensive use of overhead, of cost, of conservation, of tuning up the railroad for greater production. Locomotives of greater horsepower, greater efficiency and greater economy have already answered the important power part of these questions. The live money-making locomotive is here. Further success of our railroads demands more of them quickly and the elimination of wasteful ones as quickly. Business is growing. Remember that freight traffic has more than doubled in 20 years, that this is the day of 10,000-ton freight trains, of 1,600-ton passenger trains, of 800-mile passenger runs and three division freight runs.

A dozen years ago, seven railroads built 89 big powerful locomotives that took the place of 170 weaker ones. The new locomotives averaged an increase of 63 per cent in load per train and a decrease of 36 per cent in coal per ton mile. On one of these roads each new engine replaced two earlier ones and burned the fuel of one of them. This was due to merely an increase of weight and power plus the aid of only two fuel efficiency factors, the brick arch and the superheater. We now have additional factors to work with, improved knowledge in designing and operating improvements.

Three years ago a progressive road put a lot of new locomotives into service. A stated amount of freight was handled by 48 per cent less locomotives than ever before. Think of this in terms of fuel.

This is our heritage, our opportunity. This opportunity is widened by the fact that the improved locomotive has come to be considered a vital factor in economical railroad operation instead of a mere puller of trains. This makes a mighty difference. By the men to whom the locomotive means most it has been too often regarded as a necessary evil; not so today.

It is time to give our locomotive policy the "third degree," time to compel the locomotive to reveal its maximum operating possibilities, time to take advantage of those possibilities. After almost a century of heroic service it has emerged from crudity into efficiency. This has revolutionized rail transportation into larger units with prompt, quick performance at lower cost. Take stock of the five years just pased, the years of great advance in application of business principles combined with engineering principles that have transformed the locomotive, that we have been satisfied with for so many years, into the economical super-power steam locomotive and have carried the steam generating plant of the locomotive, the combined furnace, boiler and superheater, beyond the most advanced commercial stationary plants in unit capacity and in efficiency. It is time for every railroad to survey and intensively study its power, its power policy and its operation in relation to power and to revise operation to use the new locomotive power plant effectively. In all railroading there is no other opportunity so financially promising, no other opportunity so sure to make strong roads stronger and so sure to enable weak roads to escape receivership.

*A Paper Read Before the Convention of International Railway Fuel Ass'n.

Shorten the Railroad

Speeding up railroad operation is the first "fundamental fuel factor." "Ton-Mile-Hours" is the measure of efficiency of power and of operation. To produce maximum ton-mile-hours per locomotive, per unit of total cost is the task of today. This means moving more tons faster and cheaper. It means improvement of the locomotive as a power plant to the upper limit of our knowledge, experience, vision and courage and then immediate replacement of wasteful locomotives with money-making locomotive power plants.

It is an economic fact that track space, with all the investment and cost it represents, is too valuable today to permit a foot of it to be taken up by any but the most efficient locomotive power plants that can be built. When this principle is understood and when the significant accomplishments of improved locomotives during the last five years are comprehended the greatest campaign for reduced cost of operation will start. Dollars will be saved where pennies are saved now. "Fuel" will start it, because when we use fuel efficiently we use nearly everything on the railroad efficiently. Fuel use is the supreme key test of railroad operating efficiency.

All is ready except mental and business attitude with respect to the improved locomotive as an operating unit. Performance is proven. Several hundred improved locomotive power plants have reduced the cost of transportation and have charted the course for the future. As the improved marine power plant brought the big, efficient, economical ship so will the improved locomotive power plant bring the big, efficient, economical train. There are such trains today. In the light of facts of experience their number is too small.

Five problems have been solved by the super-power steam locomotive—First, Hauling heavier trains faster. Second, Provision for future peak loads; Third, Replacement of existing wasteful, really "red ink," engines by a smaller number of efficient economical units. Fourth, Shortening the railroad by increasing speeds, and Fifth, Reducing overtime by shortening the day's work.

Inequality of train speeds is the thing that kills operating economies. Operating costs will come down in proportion to the ability of a railroad to operate the maximum number of money making trains without sidetracking for trains that can go faster. This calls for power to pull profitable freight trains at higher speeds. It calls for high power to wipe out the loss of revenue of productive freights waiting to get a chance to use the railroad.

"Somebody pays for the carrying cost of freight in transit before it reaches a market. It is secured by bank loans somewhere and the interest runs into hundreds of millions of dollars. Even a 20 per cent saving in time between producer and consumer means something in everybody's pocket."

Hauling heavier trains faster increases the speed of operation. Increasing average freight speed increases the capacity and economy of operation of the road. It defers additional tracks. It reduces operating cost. It demands high horsepower which can be and must be had at lower cost. To provide high cylinder horsepower is comparatively easy. To supply enough snappy steam for continuous high cylinder power was the problem that waited for years to be solved. Cylinder power applied to driving and trailing wheels starts the train and limits its weight. At speeds above about fifteen miles per hour the grate and boiler pull the train and limit its operating speed. High cylinder power, with provision for maximum economy of steam in the engines, and generous as well as economical steam making capacity in the boiler is the necessary combination that has made good and that future economical operation requires.

Careful attention has been given to the development of capacity for starting heavy trains. Splendid results have been obtained. This has been far from mistaken policy. The work done to raise the starting end of the drawbar pull speed curve revealed the need for and opened the way to raise correspondingly, the speed portions of the curve.

Grate Ability

Study of locomotives recent and less recent indicates no lack of engine horsepower, but a real deficiency in steam making power, compelling wastefully high rates of combustion. Resort to double heading frequently comes from the need for two grate areas rather than two sets of cylinders. The business questions involved are too momentous for these combustion conditions to continue on any railroad whether the fuel is coal or oil.

We face again the same problem that we faced thirty years ago. Then power at speeds was had at the expense of high rates of combustion and at best was limited by grate areas. This brought wider fireboxes. Heavy back ends of boilers brought the trailer truck. Relief for the time was provided, but we have reached and often passed the limits of carrying capacity of a single trailer axle. This had become the threatening limit of locomotive progress. Rates of combustion are again excessive. Greater power at speeds is needed and additional weight accompanying larger grates must be divided between two trailer axles. No matter what else is done, at present there is no other way to solve the problem. We must turn to the four-wheel trailer truck for two reasons—for greater sustained power, for greater economy. The four-wheel trailer unit was developed by combustion engineers to remove the limit to further locomotive furnace progress, which means the limit to further locomotive progress.

This must be assisted by every possible means for economy in use of steam in main engines and auxiliaries, and by every other practicable improvement making for higher horsepower at speeds. Following this another vital thing is necessary—co-ordination of all factors of efficiency into a design that gives each factor opportunity for perfect team work with every other factor to produce utmost power per pound of metal and per pound of fuel. The vital importance of this principle has been proved. It should be immediately recognized and accepted.

Locomotives as Complete Units

It is fortunate for fuel conservation that more thought is concentrated on improvements in locomotives as complete units than ever before. A change has come. Standards have been raised. Lima Locomotive Works has produced startling results in its development of the 2-8-4 type. The American Locomotive Company has brought forward the three cylinder principle. The Baldwin Locomotive Works is engaging its great resources in locomotive improvement, including deevlopment of the Diesel locomotive. Mr. J. E. Muhlfeld has worked out high boiler pressure combined with compound cylinders and the water tube firebox. One of our great railroads is operating six hundred locomotives with marked fuel economy by aid of limited full gear cut-off. It is appropriate to comment here particularly on the first mentioned Lima development because little has been said publicly about it.

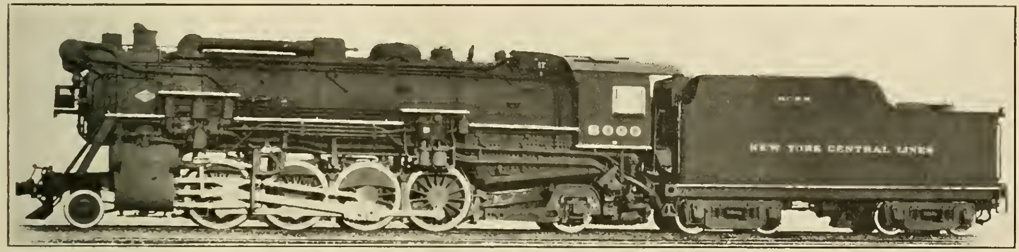


Fig. 1—Mikado Type Locomotive Built by Lima Locomotive Works, Inc.

After years of preparation and study of the problem of locomotives of great power, Lima Locomotive Works conceived, designed and built at its own expense, "Lima No. 8000," Mikado type, which went into trial service, June 6, 1922. It was the immediate response to a call for units of greater power to provide for traffic of growing weight and density where the time element had become exceedingly important. Power to handle heavy trains and also capable of hauling heavy fast freight was needed. An economical "all purpose" freight locomotive was wanted. No. 8000 met these requirements. This locomotive, Fig. 1, established a new class on this road. After eight weeks of severe road service and rigorous tests it was taken over and 150 more were built from the same drawings, half by Lima and half by another builder. A little later 150 additional engines were ordered, making 300 of them now in service. Weight limits were rigid. With weight increase of 2.1 per cent over that of the previous standard Mikado of the road, No. 8000 increased drawbar pulls as follows:

At starting 39 per cent.
At 30 miles per hour, 28.5 per cent.

This increased power ranging from 28.5 per cent to 39 per cent enabled this locomotive and its successors to increased the average freight train speed on one of the districts of the road from 12½ miles per hour to nearly double that speed, but with no decrease of tonnage per train, thus shortening the railroad.

Fig. 2 compares drawbar pulls of No. 8000 with those of the previous standard Mikado of the road in starting and up to 40 miles per hour. The previous standard engine was and is now generally considered as representative of satisfactory power. It fairly represents many thousands of locomotives that are hauling the freight of the country today.

Fig. 3 compares No. 8000 with the previous standard with respect to drawbar horsepower and coal consumption from dynamometer records over an entire division. These formance of the No. 8000 class. These improvements provide means for obtaining still higher horsepower output by co-ordinating improved cylinder design with increased boiler capacity.

The boiler of the 2-8-4 type is proportioned to obtain maximum economy for high boiler output which is accomplished by aid of a very large grate area of 100 sq. ft. This results in low rates of combustion at maximum capacity and avoids the drop in efficiency which occurs when a locomotive with limited grate area is forced to operate at high capacity. This large grate is carried on an articu-

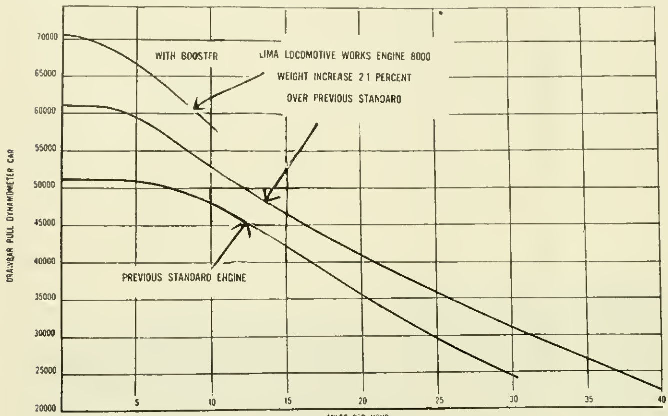


Fig. 2

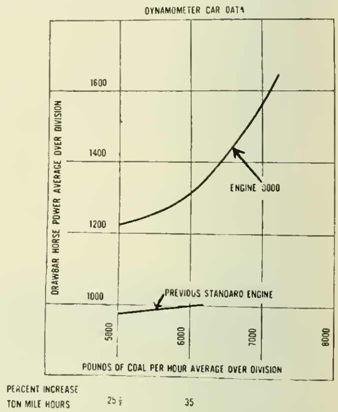


Fig. 3

curves record, for No. 8000, 25.5 per cent increased drawbar horsepower over the division when burning 5,000 lbs. of coal per hour and 35 per cent when burning 6,000 lbs. of coal per hour.

This means an average of one-third more power over an entire division with the same fuel; three new engines doing the work of four earlier ones for the fuel of three of the earlier ones. Three hundred of these engines are real fuel efficiency factors.

Operating popularity of No. 8000 and its immediate lated four-wheel trailer truck of new design which is equipped with a booster motor. This articulated trailer truck provides also for ample air supply and large ashpan capacity, which promote economy of operation. The result is very high horsepower output with great economy in boiler and cylinder performance which means large fuel savings.

This locomotive entered trial service February 20, 1925, as "Boston and Albany No. 1." The operating results aimed for were as follows:

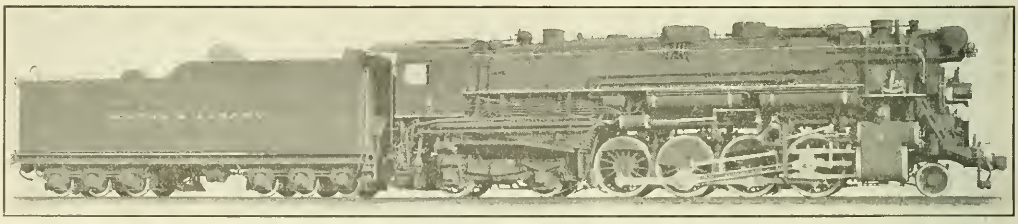


Fig. 4—2-8-4 Type Locomotive Built by Lima Locomotive Works, Inc.

successors led to the desire to produce locomotives that would further reduce operating costs. High horsepower capacity proved to be an essential factor and was accompanied by a marked reduction in fuel consumption per unit of work done. This 2-8-4 type locomotive, Fig. 4, successor to No. 8000, also was conceived, designed, built and is owned by Lima Locomotive Works.

It incorporates the improvements which No. 8000 demonstrated to be essential to further improvement of economical railway operation and to these are added other developments and improvements which have resulted from observations and searching test investigations of the per-

For slow speed drag service to pull the same trains as engine No. 8000 with 20 per cent less coal.

For high speed freight service to pull the same trains at the same speed as No. 8000 with 12 per cent less coal.

To deliver 10 per cent more drawbar pull than No. 8000 for the same amount of coal.

Tests of the 2-8-4 engine have conclusively shown that it not only meets these predictions but exceeds them. One of the fundamental principles incorporated in this design is maximum boiler output at low rates of combustion per square foot of grate and consequently high boiler efficiency. The preliminary test figures indicate that the rate of combustion per square foot of grate actually obtained are even lower than anticipated which means corresponding increase in boiler efficiency.

Individual Fundamentals

In three directions locomotive fuel conservation is going forward rapidly—1. Improved locomotives as complete units, already referred to. 2. Improved single efficiency factors for application to existing as well as to new locomotives. 3. Features making for increased service and improved operation of locomotives.

Single factors for fuel efficiency are numerous and very important. Space permits only brief comment on some of these elements for co-ordinated design for high power with fuel conservation. These may be classified into the following groups:

1. Steam making or boiler improvements.
2. Steam using or cylinder improvements.
3. Machinery improvements.
4. Operating improvements.
5. Track effect improvements.
6. Research, records, knowledge of what we are doing.
7. Co-operation.

1. Steam Making Improvements

High steam pressures promise great economies. They are likely to revolutionize design of boilers and engines. The economy lies in the fact that high pressures produce increased power without proportional increase of heat from the fire. Pressures of 150 and 350 pounds are used successfully with promise of higher pressures as water tube fireboxes develop.

Low rates of combustion are necessary. A fire that is forced is wasteful. Thirty years ago rates went as high as 200 lbs. of coal per square foot of grate per hour. Rates on big engines today run to 150 pounds and over. This is wasteful and calls for larger grate areas to reduce this figure one-half.

Higher superheat means greater economy. It reduces the work of the boiler by improving the economy of the cylinders. Superheated steam for auxiliaries greatly reduces the drain on the fire. This economy is equivalent to increasing boiler capacity about four per cent.

Gas velocities are high. It is important to reduce them by increasing gas areas through the flues as much as fixed limits permit.

Air admission to ashpans needs careful attention. A big engine working hard wants as much as 50 tons of air per hour. Few of them get it. Gas speeds through fireboxes range from 100 to 200 miles per hour. A firebox is often filled with gas over six times per second. Restriction must be avoided and spark loss must be reduced. Ashpans need about a cubic foot of capacity per square foot of grate area. Only one engine with adequate grate area now provides it.

Brick arches in fireboxes are more important than ever. The call for more power increases their duty and the value of their performance.

Anything that improves boiler circulation contributes to capacity and economy. This is specially important in the firebox. This and additional firebox heating surface are the reasons for the success of the thermic syphon.

Two separate trials of water tube fireboxes are being watched with interest.

Feed water heating by reclaimed heat is an established capacity and economy factor. Every locomotive in anything like continuous service is unnecessarily wasteful, if not equipped with an efficient feed water heater to take some of the heat from the stack to save as much from the fire. The addition of a feed water heater resulted in a coal saving of 14 per cent by a locomotive representing the then lowest fuel record.

Steam separators to remove moisture from the steam on its way to the superheater merit attention for the sake of economy. As boilers grow larger it is difficult to provide steam space for the enormously increasing volumes of steam used. It is correspondingly important to relieve the superheater of double duty, evaporating water that goes over and also superheating the steam.

Stokers render it possible to develop the capacity of large boilers. They constitute a fortunate addition to the capacity increasers. They carry the horsepower curves further into the higher speeds. Hand-firing distinctly and definitely limits the horsepower capacity of big engines. This adversely affects fuel performance. Stokers will improve economies still further as rates of combustion are reduced by use of larger grates.

The possibilities of pulverized coal as a conservation factor should not be overlooked.

The use of lignite and other low grade and low cost fuels is a promising field for further development.

2. Steam Using or Cylinder Improvements

Any fuel waste is bad, but the worst waste is to make expensive steam and then throw a large proportion of it away by crude cylinder work.

Expansive use of steam in freight service may be provided by design that limits the full gear cut off in a manner to prevent the locomotive from making continuously indicator cards like those of a "full stroke" steam pump. Without this feature heavy slow drags for hours at a time compel the cylinders to operate with practically no expansion of the steam. To "full stroke" a locomotive for long periods violates the first rule of steam engineering established by James Watt. The limited cut off principle not only saves fuel at low speeds, it results in significant increase of capacity at higher speeds. It does not involve any mechanical complication whatever. It provides additional tractive effort at low speeds because it smooths out the torque curve in starting, incidentally, as much as the three cylinder arrangement does.

"Cut-off" in locomotive operation requires more attention by fuel officers than it has ever received. There is a correct, economical cut-off for every different speed of the engine, one that develops maximum power for minimum steam at every different speed. Until recently this has been left to guesswork on the part of the engineman and no two men will adjust the cut-off over a division in the same way. This is one reason for wide variations in performance as to tonnage and fuel records among several men running the same engine, even when they are equally careful men. In a test for water consumption made five years ago one of five enginemen used 16 per cent less water over a division than the average of four others, all running the same engine on the same train. All five ranked as good men. They handled the cut-off differently. To save fuel by use of correct cut-off it is necessary to establish the proper cut-off for every class of engines for every speed and provide means for showing the engineman the speed and what cut-off to use for each speed and every change of speed. Perfection of power reverse gear mechanism has opened the way to large savings in properly taking advantage of steam expansion as an economy and power increasing factor. But it is necessary to indicate to the engineman the proper adjustment to be made. Cut-off adjustments have also been made automatically, controlled by the back pressure.

Improved valve gears and increased valve travel offer means for improving cylinder performance, reducing back pressure and reducing the steam required from the fire.

Mechanical draft in place of induced draft offers the advantage of cutting down back pressure against the pistons. This is an attractive and promising field for development. A loss of several hundred horsepower at high speeds, due to excessive back pressure, emphasizes the importance of this subject which is now receiving careful attention.

Trailing wheels temporarily used as tractors in starting and in helping over hard pulls reduce fuel cost per unit of work done. This principle aids greatly at the low speed end of the drawbar pull speed curve, and in facilitating acceleration. It permits of greatly increasing ton miles per train hour by increasing operating speed. It reduces the length of time an engine (without limited cut-off) must be "full stroked" in starting and helps every engine in accelerating. It is a capacity increaser and a fuel conserver.

3. Machinery Improvements

Many locomotive parts are unnecessarily, yes, absurdly, heavy. Cast steel cylinders saved two tons in the Lima 2-8-4 type engine. Also many other parts were lightened. Unnecessary weight requires unnecessary fuel to move it many miles a year for many years. Such weight restricts the weight of the boiler and robs it of some of its capacity. Weight saved in reciprocating parts saves more than mere weight. It reduces dynamic augment and opens the way for greater static weights on drivers. Appropriate use of alloy steel forgings and castings affects fuel favorably when applied carefully in many details to save weight.

Between lubrication and fuel there is an important relations. It is estimated that the difference in fuel required to haul a freight train of 60 cars over a division at usual freight train speeds with high grade and lower grade oil is as great as 200 pounds of coal per hour. This suggests searching operating tests of car lubrication. Lubrication of the locomotive itself merits more attention from the operating point of view. A large Mikado rubs two and one-third acres of moving surfaces per mile run. A single drop of oil is called upon to lubricate a surface of about 400 to 500 square feet in the cylinder and valve chests of a big engine. Lubrication of locomotives, therefore, requires the best of lubricants and the best application of them. The day of the "oil hole" passed with the days of short locomotive runs. It is necessary to put the locomotive in the class of the automobile, airplane, airship and steamship with respect to lubrication of its machinery. The locomotive depends upon perfect lubricants, perfectly applied, just as much as do the other services mentioned. It is lubrication that has made these developments possible.

Lubrication affects locomotive fuel in several ways that escape attention because results are hidden in frictional resistance of rubbing parts, in loss of steam by leakage past worn piston and valve rings, in loss of power due to unequal steam distribution, caused by wear of valve motion parts, in loss of power due to increased back pressure, caused by deposits in exhaust passages, in loss of fuel due to delays caused by hot bearings. These losses also are largely hidden because of the difficulty in summing them up. A single hot box is sure to disarrange an entire division if it is a busy one. It may cause a dozen trains to waste fuel. Lubrication is mighty important to the fuel officer. The modern locomotive provides no place for "saving money" by anything but perfect lubrication.

Every machinery improvement that reduces wear, reduces maintenance, insures certainty of operation. Everyone that prevents road failures and contributes to locomotives serviceability cuts fuel loss by reducing the number of locomotives required for a given amount of traffic. It is wise to provide lateral relief for leading driving wheels, to distribute the piston stresses over more than one pair of crank pins, as in the Lima 2-8-4 type engine, to provide improved details of driving boxes, wedges and other parts that will reduce running repairs and to employ high quality materials in new locomotives and in repairs. The modern locomotive provides no place whatever for sacrifice of quality to reduce cost.

Power grate shakers, variable exhaust nozzles, the best of piston and valve packing, piston rod and valve stem packing, roller bearings for tenders and cars—all these affect fuel.

With the designers of locomotive power plants ready in all respects, there is no real reason why a freight engine should not be coupled to a train, haul it 1,000 miles or more, uncouple, spend 24 hours in the hands of good men who are fully supplied with facilities, return for 1,000 miles, ready to do it over again and again. For years the Rhodesian Railway in Africa has operated freight engines 700 continuous miles with sleeping and cooking facilities in special cabooses for the crews. Their trains are slow. It should be easier for us to make long freight runs.

Of very great importance is the switch engine policy of the road. This subjects merits a thorough discussion of its own. It is a combined question of machinery and of operation, both sides of it affecting lots of fuel. On a busy, congested road switch engine mileage may be as great as 25 per cent of total locomotive mileage. This suggests the best of fuel conservation attention applied to switching engines. It is financially foolish to use old road engines for switching service. Railroads perpetuating this practice have no license to urge their men to save fuel.

4. Operating Improvements

Fuel fundamentals are of two kinds, those of the machine before the coal is fired and those of operation after it is fired. Train operation is a profitable study for fuel officers. Improved locomotives need study by operating officers and especially by dispatchers. Operation is an inspiring subject for mechanical officers, for signal officers. Utmost co-operation is necessary to give big engines a chance to run. The locomotive power plant burns more coal running and standing than its predecessor did. The heavy train burns more coal in stopping, standing, starting and accelerating. The big power unit must not be stopped or slowed down unnecessarily for any reason. It earns only when it moves. It must spend more of its life moving. It must make maximum mileage because of its earning capacity and its high overhead. Fuel officers are in position to aid greatly in the substitution of train direction by signal indication and in the abolition of the time killing train order, especially the "31" order that stops a train in order to tell it to proceed, also the "19" order that slows the train down for the same purpose. A slow down to a speed of 8 to 10 miles per hour is nearly as costly as a stop. Both of these orders must give place to "operation by signal indication." Many tons of fuel may be saved by the installation of automatic block, interlocking plants and machines for operating remote siding switches by power, to save two out of three stops when taking siding. Fuel officers and division superintendents, signal officers and train dispatchers will profit greatly by the closest co-operation to reduce losses in getting trains over the road. Long locomotive runs, main trackers, the "peg" and "turn around" plans, are playing a big part in fuel records. The load rating of locomotives offers another and too often neglected field for fuel conservation. Distribution of power offers still another. The distribution question is greatly simplified in the case of "all purpose" locomotives capable of hauling with economy a wide range of traffic. To distribute power, especially on roads with seasonal service requires more attention and more knowledge of the power than is usually applied.

Water purification is distinctly an aid in operation. It is obviously important to provide proper water for power plants of any kind, particularly those intrusted with the handling of money making traffic. One of the railroads leading in long locomotive runs has given unusual attention to this water problem and has found it possible to reduce by 25 per cent the number of locomotives assigned to traffic involving long runs. It is reported that the largest investment involved in its long runs, is in facilities for improving its waters. The annual saving effected amounts to approximately 75 per cent on the total investment in those facilities. In the matter of increased firebox life the service of its fireboxes has been doubled in less than ten years. It is fortunate that means are available for water treatment that do not involve these large investments. It is well to remember the generally accepted figures that one-sixteenth inch of scale in a boiler represents a loss of 10 per cent in fuel.

Many matters are treated as mechanical which should be considered as strictly operating or business questions. Among many of these the following stand out in importance. Some of them are mentioned by name only.

Maintenance of locomotives in condition for highest efficiency. Engine terminal facilities, ash pit, inspection, boiler washing, hot water filling and labor saving roundhouse equipment such as cranes. Reduction of stand-by losses by keeping wheels turning. Location and capacity of water cranes. Increased coal and water capacity of tenders. (In some cases track tanks cannot be filled fast enough to supply ordinary tenders.) Feed water heaters to reduce water stops. Soot blowers for cleaning flues on the road. Driving boxes that may be renewed without unwheeling engines. Automatic adjusting wedges. Ash pans of adequate capacity. Power grate shakers to keep fires clean on the road and to clean them quickly at terminals.

Education of "all hands" in fuel conservation. Provision of incentives to conserve fuel. Recognition of efficiency. Individual fuel records. Cost accounting for repairs, also roundhouse expense put on a ton mile hour performance basis. Operating officers are saving fuel by helping mechanical officers to make repairs when needed instead of deferring repairs until fixed mileages, such as tire mileages, are worked out. Co-operation of superiors and subordinates to conserve fuel is an operating responsibility. The operating officer can prevent someone from wasting what someone else saves. Engine crews do not waste all the fuel that is wasted.

5. Track Effect Improvements

Between fuel conservation and immensely costly track maintenance lies a direct relation in which the fuel officer has deep interest and may exert strong influence. Four-wheel trailing units not only emancipate the boiler from its present restrictions, they relieve the track from the punishment received from single trailer wheels. Single axle trailers necessarily must be located considerably in the rear of the rear drivers. As the engine proceeds the drivers depress the track and it springs up to be knocked down again by the trailers. Rail records of the American Railway Engineering Association show that trailers frequently stress the track more than a pair of drivers. This was the reason for the substitution in rail stress tests several years ago, of a four-wheel trailer truck for the single axle trailer truck on one of the big 2-10-2 type locomotives on the Santa Fe. Here is a conservation improvement that will enlist the interest of maintenance of way officers. Another one relieves them also. Light reciprocating parts not only help the boiler, they also help the track by reduction of the rail stresses imposed by the counterbalance. Lateral motion for forward driving axles eases big long engines over the road. All of these items also record themselves in fuel conservation.

6. Knowledge of What We Are Doing

Armies do not go into battle with guns that have not been thoroughly tested. Navies do not meet in battle with ships the ultimate possible performance of which in all respects is not previously determined by exhaustive trial. But railroads seldom put their new locomotives through their paces to prove that the policy of their design is correct and that the promise of their performance is attained. Without truly exhaustive road tests with dynamometer car and trained crew they never know that the new engine really is what they need and want. Furthermore, they never know during the third of a century of life of that engine what its limit of performance is as a basis of what in operation it can be made to do. Any railroad, except a small one, that does not keep a good dynamometer car busy getting money making operating information, will some day have a lot of explaining to do as to why so much money was lost.

No railroad can be said to have a locomotive policy unless it has a busy dynamometer car. No railroad can "distribute" its power intelligently or claim that it is making a real record of fuel economy without one. Lack of definite knowledge of the operating possibilities of improved locomotives has done more than any other one thing to retard the progress of the locomotive and the advent of the locomotive power plant. Fortunately this obstruction is being removed. To be efficient, transportation demands test plant tests for engineering data as the basis of locomotive design and complete road tests for operating data as the basis for financially profitable locomotive operation. The American Railway Association needs a test plant. Every railroad of even fair size needs a dynamometer car more than it needs any other factor in operation. Locomotives have improved not because of exact road operating performance records and facts, but in spite of a lack of them. This is not true of any other steam power development. It will not long be true of locomotive development because the importance of locomotive operating facts is greater than in any other power problem.

Real fuel conservation will be accomplished when and where there is real co-operation, when a very high official compels it. An officer, in position to do so, will ask: "Is our locomotive policy right, our car policy, our maintenance, our yards, our locomotive terminals, our side tracks, our signals and our operation?" Every one of these affects every other one and every one affects fuel. They can be best answered affirmatively by co-operative concentration on one thing—*Fuel.*

This discussion covers only some of the high spots as to Fundamental Fuel Factors. It is a partial catalog of the tools we have to work with to transform our "locomotives" into "efficient operating units." It shows what we have done with some of them.

Let us pull heavier trains faster at lower cost. It is speeding up operation meaning higher horsepower that brings increasing revenue to the railroads that are taking advantage of the locomotive power plant. It is time to give "tractive effort" its proper place, which is in starting, and to think of sustained high horsepower to make more money. Let us quit buying mere metal and buy "horsepower" as our marine and manufacturing friends do.

Like a successful doctor, a railroad official is in position to hand on to the future living evidences of his knowledge, experience and skill. The locomotive is a living force for influencing the happiness of mankind by efficient service for the benefit of every man, woman and child in the land. Set its standard in fuel performance. Raise this standard as knowledge of how to do it develops.

Frame a locomotive policy. Follow it.

Let us quit regarding a locomotive as a satisfactory machine merely because it looks like a locomotive, smells like a locomotive, and is absurdly heavy. Let us ask what it does and use it or discard it accordingly. Let us be done with the prattle of the past and take up clear, strong talk of grown men.

Committee Report on Front-Ends, Grates and Ashpans

The Committee on Front-ends, Grates and Ashpans early in the year agreed to limit its report to the results of experiments on the use of restricted air openings in grates, which it had learned were in progress on two Western railroads.

It was then expected that the results of these experiments would be available in time to present them in detail at this convention. In that expectation, however, we have been disappointed; and we are able at this time to give only a general statement of the purposes of these tests and some general observations on the results thus far obtained. We hope in the future to make a more extended report on this subject; but the brief statement given below is presented in the hope that it may lead to useful discussion of this and related topics.

On one of the roads referred to, the use of grates with restricted air openings was apparently undertaken primarily because of loss of coal through the grates, which with friable coal which does not soften and coalesce on the grates may assume serious proportions. On the other road the restricted air openings were first used in locomotives burning lignite, and the practice was resorted to chiefly because of the difficulty of maintaining the fire bed in good condition with grates of the ordinary design. It appears, therefore, that in both cases restricted air openings in grates have been used largely because the coal to be burned was in some respects unusual, and your committee is of the opinion that such a practice will be justified only under special conditions and that it is not likely to become widespread.

In our report at the Convention of 1922, the committee summarized its views with respect to the air opening in grates in the following statement:

"The committee has previously recommended that for the majority of coals in use, the air openings through the grates be as great as is compatible with the mechanical strength of the grate bars. The data secured by the committee for its reports of 1915 and 1916 show that on locomotives burning bituminous coal the air opening in the grates in service runs as high as 70 per cent of the grate area, although this is rare. Fifty per cent air opening is not uncommon, and the average of the designs reported to the committee was about 40 per cent. On locomotives burning anthracite coal the prevailing air opening averaged nearly the same amount, although the maximum was only 45 per cent.

"It is obvious, however, that with certain fine and friable coals maximum grate opening will entail undue waste of coal through the grates; and it is unfortunate that many such coals, like lignite for example, are the very ones which, from the point of view of good combustion alone, ought to have maximum air supply and the greatest air opening in the grates. Such coals evidently call for a compromise in designing the grates.

"It is clear that the air opening through the grates must continue to be determined with some reference to the kind of coal in use, and that for many kinds of fuel grate design must be a compromise between the desire to obtain maximum air opening and the necessity of avoiding undue waste of coal. Under the circumstances, probably no positive recommendations can be made with respect to air openings which would be generally applicable and satisfactory for all fuels."

The committee sees no reason to change the opinion thus expressed and it believes that for the majority of railroads and for most of the coals in use the aggregate air opening in grates should continue to be made as great as the circumstances permit. With this understanding we are glad to submit the following statements concerning the practice of restricting the grate openings.

With reference to its experiments the first of the two roads referred to makes the following statement: "We have done a great deal of experimenting with different designs of table grates compared with the standard finger grates such as are ordinarily used in locomotives. We went into this experimental work on account of the waste, due to fuel falling through the finger grate in an unburned or partially burned condition.

"There were a number of different designs of table grates tested. These grates had different size and shape of air openings, but all of them restricted the percentage of air opening through the grate as compared with the standard finger type. Smoke box gas analyses which were made indicated that there was still four to five per cent of free oxygen in the flue gases, which indicated that the air opening was greater than was required for complete combustion. We therefore reduced the size of the opening still further until the effective air opening through the grate is about sixteen per cent of the total area. It has been found in tests tha tthis grate materially increases the percentage of carbon dioxide in the flue gases, and reduces the free oxygen and it is thus proved that better combustion was being secured. We are now using this new design of grate extensively in our modern power and we have found that it results in a distinct saving in fuel, due both to better combustion and to the elimination of wastage through the grates."

A subsequent letter states that "the tests so far indicate about a 6 per cent saving in fuel with these grates over the standard finger grates." The grates in use on this road are table grates provided with conical air holes whose diameter at the top surface of the grate bar is ¾ of an inch and at the bottom surface, 1 1/16 inches. As stated above the aggregate area of the air openings is only 16 per cent of the grate area.

The Northern Pacific is the second road carrying on such experiments and the information given below is quoted from a letter written by M. S. Daly, General Fuel Supervisor, who says: "We became interested recently in grate experiments because of our desire to satisfactorily burn in locomotive service a high moisture coal (lignite) from the Rosebud Vein in Montana, whose average analysis, in the condition in which it was fired, is:

Moisture	25.66 per cent
Volatile	28.39 per cent
Fixed Carbon	38.59 per cent
Ash	7.36 per cent
B. t. u.	8,743.00

"Rosebud coal in burning shows a tendency to break up into small pieces as it becomes heated. When the gas is largely driven off the fuel has become a mass of rather small particles and there seems to be very little cohesion between these coal particles. Consequently, with a short draft, these particles are easily moved about in the surface of the fire bed. When using the old grates, which had ¾-inch slots, the rush of air through the grate openings at the moment of exhaust disturbed the coal on the more thinly covered portions of the grate and tended to uncover the grates at these places. We found that by reducing the size of the openings through the grates these disturbing air impulses were diminished in force and we were able better to control the fire.

"In trying to find the most suitable size of grate perforation we have experimented with round hoels having diameters of ½ inch, ⅝ inch, and ¾ inch; and we have varied the aggregate air opening from 18 per cent to 15 per cent of the grate area. The grate bars are flat slabs composing the so called table grate.

"On account of the pressure of other test work we have not yet been able to make with these grates accurate road tests which might enable us to draw definite conclusions as to their efficiency, but we expect soon to carry out such tests. We certainly do find that with reasonable care the fire is much more easily maintained in good condition on these grates with restricted openings than on standard grates. Strange as it may seem, we have been able to burn satisfactorily on the Rusebud grates several of the standard coals—varying from Pittsburgh No. 8 coal from Ohio to a semi-bituminous coal mined in Montana which has approximately 18 per cent ash and 10,300 B.t.u. We expect to find a slightly increased efficiency even in the use of standard coal on these grates.

"These grates have been applied on two types of Northern Pacific locomotives whose dimensions are as follows:

	Class W	Class W-3
Size of cylinders	24×30	28×30
Weight on drivers	206,000	240,500
Tractive Force—lb.	46,600	57,100
Total weight of engine—lb.	263,500	320,000
Heating surface—direct—sq. ft.	2,860	3,591
Heating surface—superheater—sq. ft.	570	838
Grate area—sq. ft.	43.5	70.3

On both of these engines the grates now in use have conical round holes whose diameter at the upper grate surface is ½ inch and at the lower surface, ⅞ inch. On the Class W engines the aggregate air opening is 12.2 per cent of the *grate bar* area and on the Class W-3 engines it is 13½ per cent of the *grate bar* area." Mr. Daly seems to be of the opinion that their success in the use of this grate is not to be ascribed to the reduction in the *aggregate* air opening but primarily to the *size* of the individual holes through the grate. These have been so far reduced that even under heavy exhaust impulses the jet of air drawn through the opening is not strong enough greatly to disturb the coal particles which lie above it.

As stated above your committee had hoped to be able to present much more detailed information concerning this development in grate design and we regret that the work on these two roads has not progressed to the point where we can present full details; we trust, however, that this general statement will provoke discussion of the air supply for locomotives, and bring out information from those who may have had similar experiences in burning light and friable coals.

Air Brake Association Convention

The thirty-second annual convention of the Air Brake Association was held at the Hotel Alexandria, Los Angeles, Calif., May 26-29 inclusive. The association was addressed on behalf of the railroads by W. K. Etter, general manager of the Atchison, Topeka & Santa Fe Coast Lines, and also by W. J. Patterson, assistant director, Bureau of Safety of the Interstate Commerce Commission. President C. M. Kidd, air brake inspector, Virginian Railway, presided.

On the opening day, a paper was presented by the Central Air Brake Club on "Passenger Train Handling; Graduated Release," which was read by James Elder, supervisor of air brakes, Chicago, Milwaukee & St. Paul Railway.

The sessions of the second day were devoted to the presentation and discussion of a paper by the Pittsburgh Air Brake Club entitled, "More Efficient Air Compressors." This was read by C. B. Myles, supervisor of air brakes, Cleveland, Cincinnati, Chicago & St. Louis Railway; and also to reports of committees on "Condemning Limits of A. R. A. Standard Triple Valve Parts," and "Train Control Talks."

The third day was devoted to the committee report on Brake Pipe Leakage, a paper on "What Are You Specifying and What Are you Getting in Foundation Rigging of Car Equipment," by the North West Air Brake Club, "Triple Valve Slide Valve Leakage Indicator," by the Manhattan Air Brake Club, and the committee report on "What is the Best Material for Air Brake and Air Signal Piping."

The fourth day was devoted to other committee papers and the election of officers.

The exhibit of the Air Brake Appliance Association was a feature of the convention.

Snap Shots

By THE WANDERER

A good many years ago an engineer who was trying to establish himself in a business and a reputation, was at work in his library one evening, when his wife came to him and asked when he was going to get through with this everlasting studying.

He replied: "My dear, if you will go out and get the rest of the world to stop developing, it is barely possible that, by hard work, night and day, I may be able to so catch up that I will be in sight of the procession in twenty years."

Which is but another way of expressing the hopelessness of an engineer so much as attempting to keep *en rapport* with what is going on. Just as it is impossible to have a scientific book quite up to date when it comes off the press regardless of what it might have been in the author's manuscript.

Apropos of the pace at which we are driving, just look at our new locomotives. Within a few months, as months go in these days, we have had four new developments, each holding the center of the stage for the brief interval of its exploitation and then retiring, not out of sight, but to the side lines, there to join the chorus of things accomplished that are well worth while, and there to reap the rewards that sometimes come to fine achievements.

These, however, are the stars in the engineering drama that are finely sustained by a good company of featured artists whose names are printed in smaller type in the posters, and may not even be read by the casual passerby.

But the array of talent that is at work in the making of this drama passeth belief. I find in my passing to and fro, that apparently every superintendent of motive power, every shop superintendent, every foreman, is scheming to improve the efficiency of the machines for whose operation they are severally responsible. And the discouraging part to the struggling wight who is attempting to keep abreast of the times is that the great majority of these attempts are successful. Sometimes, to be sure they are only repetitions of past successes or the dragging of a failure into the light of success, but whether one or the other, they are achievements that must be reckoned with.

This modern progress has been likened to a body moving under the influence of gravity. There is a constant acceleration of its velocity. A steady increase added to whatever speed may have been previously acquired. We are told that eventually a maximum speed will be attained after which the velocity will be uniform. In mechanics we seem to be far from having acquired the maximum velocity, but even if we had our progress would be terrific. And even this would probably be increased if we could but cut out the duplication of effort and especially futile effort.

And right here we have a matter, let us call it of ethics, for want of a better name.

Successes are broadcast, they are shouted from the housetops, but failures are usually carefully hidden away under a bushel. No man wishes to proclaim a failure, but what a valuable book that would be, "The History of Failures, Being a Full and Complete Account of the Failures to Achieve Results in the Realms of Science and Mechanics."

It would be a tale of heartache and discouragement, but what a valuable warning to those who follow. It would be the danger sign on thin ice, telling the unwary what to avoid, but by that very warning, possibly pointing out a way to safety and success. With such a possibility of value to mankind our question of ethics comes in, and we ask whether it is right and proper for the man or the concern who has tried to achieve a result and failed, not to post his sign of danger and thin ice and tell what he did and how he did that which resulted in a failure. It would at least prevent another from following the same route.

Let us suppose a case. Let us take any known principle and try to apply it to, let us say, locomotive practice. For the sake of argument we will suppose ourselves to be skilled in the art of locomotive designing and with ample resources at our command to execute our plans. We also have such an organization behind us that we are assured of a disposal of our results if they are successful.

So we start in blithe and gay and work for weeks and months, but to no avail. That beautiful principle simply will not do as we want it on a locomotive.

Meanwhile we have been working behind closed doors and no one knows anything about our work except that we have been struggling to bring this naughty principle into line and that it wont come.

Now, of course, our legal rights are perfectly clear. Our failure is our own, and we can give it any sort of a burial that we choose. Most likely we can secretly cremate it in the smokehouse and look the world in the face. But is that fair? Ought we not to come frankly to the front and tell what we did to that principle so that no one else may be misled by its beauty to treat it as we have done? Perhaps with such information, as we can give, at hand some genius may profit by our mistakes and give something of value to the world, without traversing the same dreary and discouraging road that we have trod. Or mayhap our work has been so thorough that the principle is killed beyond the possibility of resurrection so far as the locomotive is concerned.

So ought we not to tell what we have done? Our little world already knows that we have failed, and the telling of the story of our failure cannot injure us and may be of inestimable value to others. What do you think of it? Should we let our legal rights or ethical obligations prevail?

General passenger agents and general freight agents have been busy of late years in preaching the doctrine of courtesy and affability to their subordinates, and urging that its cultivation will be an asset both to themselves and the company which they serve. All of which is very commendable and the results, if any, are duly appreciated by the public. It sometimes happens, however, that such propaganda would seem to be intended for the benefit and practice of subordinates and not for home consumption, as it were. In such cases it is as though the words were: "Follow the precepts of my preaching, but avoid my practice."

It occurs to me that courtesy and affability are quite as becoming the heads of a department as any subordinate in it.

These musings are the result of a contemplation of the career of a certain departmental head. Of undoubted ability he has climbed all the rounds of the ladder of promotion until he has reached the top. And through all the early years of his climbing he was the subordinate of men of courtesy who were imbued with the spirit and desire to be helpful. And he, in making good the adage of "like master, like man," was all that could be asked. But when his superiors dropped off, and he found himself standing on the topmost rung, it seems as though he became dazed because of the swelling of his head, that resulted from his unwonted elevation, and the whole nature and demeanor of the man changed. Instead of the easily approachable gentleman anxious to do a favor, he has become the arrogant recluse whose letters are models of disagreeable insolence.

But as neither he nor his subordinates come in contact with the public as the public is understood to be the great mass who are the patrons of the road, it would hardly appear that his demeanor would work very much harm, and perhaps it does not. But already his reputation is traveling far afield and at places and on roads far removed from his own particular bailiwick, he is being spoken of as the acme of disagreeableness. And so, perhaps, after all, it may be just as well for the good and reputation of a road that the official staff should cultivate among themselves that courtesy and kindliness which they preach so loudly should be the daily practice of their subordinates.

Machine Tool Exhibit at New Haven

Over 150 exhibits are already scheduled for the New Haven Machine Tool Exhibit to be held September 8-11, 1925, in the Mason Laboratory, Sheffield Scientific School, Yale University. All the machinery exhibited will be in actual operation on production work. This is the only exhibition where an educational institution of the prominence of Yale University co-operates with a prominent industry in purely educational demonstration of practical application of intricate mechanisms to promote the progress of daily endeavors of the public.

Technical sessions are arranged by the Machine Shop Practice Division of The American Society of Mechanical Engineers. The engineering faculty of Sheffield Scientific School joins wtih the New Haven Chamber of Commerce and the New Haven Section of the A. S. M. E in promoting this exhibition.

New York Central Long Locomotive Runs

The New York Central is now running its passenger locomotives through between Chicago and Buffalo without change. The distance is 520 miles, and is probably the longest regular runs established with coal burning locomotives.

Notes on Domestic Railroads

Locomotives

The Atlantic Coast Line Railroad has ordered 25 Pacific type locomotives from the Baldwin Locomotive Works.

The New York Central R. R. has ordered 26 locomotive tenders, 20, 15,000 gal. capacity and 6, 16,000 gal. capacity from the American Locomotive Company.

The New York, Chicago & St. Louis R. R. has placed an order covering 10 heavy eight-wheel switching locomotives from the Lima Locomotive Works.

The Bear Creek Logging Co. has placed an order for one Mikado type locomotive from the Baldwin Locomotive Works.

The Standard Oil Company of New Jersey has ordered 2 switching locomotives from the Baldwin Locomotive Works.

The Newburgh & South Shore R. R. has ordered 2 switching locomotives from the Baldwin Locomotive Works.

The Delaware & Hudson Co. is inquiring for 10 Consolidation type locomotives.

The Northern Pacific Railway is inquiring for 6 Mountain type locomotives.

The Havana Central Railway has ordered 6 Mountain type locomotives from the Baldwin Locomotive Works for use on the United Railways of Havana.

The Great Northern Railway has placed an order with the Westinghouse Electric & Mfg. Co., for 4 electric locomotives, to be used on the line over the Cascade mountains.

The Missouri & Illinois Railroad is inquiring for 2 Consolidation type locomotives.

The New York Central Railroad is inquiring for 20 small Diesel type locomotives for yard service.

The Mitsui & Co., New York City, have placed orders with the American Locomotive Company for 6 Pacific type locomotives. They are acting in behalf of the Imperial Government Railways of Japan.

The Kansas City Mexico & Orient Railway has placed an order for 5 Decapod locomotives with the Baldwin Locomotive Works.

The New York Rapid Transit Corporation is inquiring for 2 electric locomotives.

The Shamokin Coal Company has ordered one switching locomotive from the Baldwin Locomotive Works.

The Donora Southern Railroad has ordered one switching locomotive from the Baldwin Locomotive Works.

The New York, New Haven & Hartford R. R. is inquiring for 10 locomotive boilers.

The Dickey Clay Manufacturing Co. has ordered one switching locomotive from the Baldwin Locomotive Works.

The Maryland & Pennsylvania R. R. has placed an order for one Consolidation type locomotive with the Baldwin Locomotive Works.

The Davison Chemical Co. is inquiring for one switching locomotive of six-wheel type.

The Indianapolis Union Railroad has placed an order for one eight-wheel switching locomotive with the Baldwin Locomotive Works.

Freight Cars

The Chicago, Milwaukee & St. Paul Railway has ordered 500 gondola cars from the Standard Tank Car Company and 500 flat cars from the Ryan Car Company.

The Great Northern will repair 600 box cars of 50 tons capacity in its own shops.

The New York Central Railroad has ordered 50 ballast cars of 50 tons capacity for the Michigan Central from the Roger Ballast Car Company.

The Chicago, Indianapolis & Louisville Railway is inquiring for 5 caboose cars.

The Quaker City Tank Line has ordered 100 tank cars of 8,000 gal. capacity from the Standard Tank Car Company.

The Green Bay & Western Railroad has ordered 150 box cars from the Pressed Steel Car Company and 50, 40 ton automobile cars from the General American Car Co.

The Fruit Growers Express has placed an order for 500 steel underframes with the Pressed Steel Car Company.

The Long Island Railroad has placed orders for 20, 40 cubic yard capacity dump cars with the Goodwin Car Mfg. Co.

The General Sugar Co. has placed an order, 130 cane cars with the American Car & Foundry Co.

The Fidelity Sugar Co. has placed an order for 130 cane cars with the American Car & Foundry Co.

The Chicago Milwaukee & St. Paul Ry. has issued inquiries covering the rebuilding of 1,000 stock cars.

The Great Northern Railway has authorized the construction of 600, 50-ton box cars at its own shops at St. Cloud, Minn. It is reported that this is the forerunner of 3,000 freight cars to be built at these shops.

The General Equipment Co. has placed orders covering repairs to 10 box cars with the American Car & Foundry Co.

The Mid-continent Petroleum Corporation has placed an order for 3, 40-ton two-compartment tank cars with the American Car & Foundry Company.

The National Refining Co. has placed an order for 2 tank car underframes with the American Car & Foundry Company.

The National Ammonia Co. has placed an order for 2, 40-ton tank cars with the American Car & Foundry Company.

The Mobile & Ohio Railroad is inquiring for 6 underframes for caboose cars.

The Norfolk & Western Railway has placed orders for rebuilding of 1,935 hopper cars as follow: 1,000 which were awarded to the American Car & Foundry Company and 935 to the Ralston Car Co.

The General Electric Co. has placed an order for 10, 50-ton flat cars with the American Car & Foundry Company.

The Chicago Milwaukee & St. Paul Railway has placed orders for 5,500 freight cars as follows: 1,000 box cars each to the Pullman Car & Manufacturing Co., the Bettendorf Co., and the Western Steel Car Co.; 500 automobile cars to the American Car & Foundry Co., and the General American Car Co.; 500 stock cars to the Illinois Car & Mfg. Co.; and 1,000 stock cars to the Standard Steel Car Co.

The Delaware, Lackawanna & Western Railroad has placed an order for 300 refrigerator cars from the American Car & Foundry Co.

The Chicago & Alton Railway will rebuild 400 box cars in its own shops.

The Illinois Traction Co. has placed an order for 50 hopper cars with the Mt. Vernon Co.

The Woodward Iron Co. has placed an order for 5 extension side dump cars with the Clark Car Co.

The Chicago Indianapolis & Louisville R. R. is inquiring for ten caboose car underframes.

The American Steel & Wire Co. has placed an order for 10 extension side dump cars with the Clark Car Co.

The Illinois Traction Company has ordered 50 hopper cars from the Mt. Vernon Car & Manufacturing Co., Inc.

The Delaware Lackawana & Western R. R. is inquiring for 25 caboose cars.

Passenger Cars

The Southern Pacific Co., has ordered 5 combination steel passenger cars with smoking compartment from the American Car & Foundry Company. They are for service on the Southern Pacific lines in Texas and Louisiana.

The Pennsylvania Railroad is inquiring for 222 baggage cars, 105 coaches, 15 passenger-baggage cars, 10 baggage-mail cars, and 5 passenger-baggage-mail cars.

The New York, New Haven & Hartford Ry., is inquiring for 20 steel underframes for baggage cars.

The Southern Pacific Co. has ordered one dynamometer from the Standard Steel Car Co.

The New York Central Railroad has placed an order for 10 combination baggage-mail cars with the American Car & Foundry Company.

The Florida East Coast Railway has placed orders for 15 coaches and 15 baggage cars with the Pullman Car & Mfg. Co.

The Lehigh Valley Railroad has placed an order for one combination passenger and baggage mail motor car with J. G. Brill Co., Philadelphia, Pa.

The Canadian National Railways have placed orders for 2 combination passenger and baggage gasoline rail motor cars with the J. G. Brill Company, Philadelphia, Pa.

The International Railways of Central American have ordered 6 observation cars from the Wason Manufacturing Company.

The Richmond Fredericksburg & Potomac Railway has ordered 4 express cars and one postal car from the Bethlehem Shipbuilding Corporation.

The Tennessee Alabama & Georgia Railroad has ordered one gas-electric car from the J. G. Brill Company, Philadelphia, Pa.

The Lake Erie, Franklin & Clarion Railroad has ordered one combination passenger and baggage gasoline rail motor car from the J. G. Brill Company, Philadelphia, Pa.

O. E. Szekely Co., Moline, Ill., is inquiring for one dynamometer car.

Building and Structures

The Reading Company has placed contract covering the construction of a freight repair shop at Reading, Pa.

The Baltimore & Ohio Railroad plans the construction of a one story addition to its Mount Clare shops at Baltimore, Md.

The Chicago Burlington & Quincy Railroad has placed a contract covering a brick and stone roundhouse at Lincoln, Nebr.

The New York, Chicago & St. Louis Railroad has been considering the construction of shops and terminal facilities at Ft. Wyne, Ind., to cost approximately $2,500,000 but has now deferred the project indefinitely.

The Great Northern Railway has awarded a contract for the construction of a power house and water tank for the new engine terminal at Troy, Mont.

The Ann Arbor Railroad has placed a contract covering the construction of a 400 ton two track automobile simplex roller skip locomotive coaling plant for installation at Frankfort, Mich.

The Chicago & Alton Railroad plans the construction of a new grain elevator at Kansas City, Mo. to include hoisting and conveying machinery and other equipment to cost approximately $500,000.

The Kansas City Southern Railway is reported to be planning the construction of a new car and locomotive shops at Port Arthur, Texas, to cost approximately $500,000 with equipment. It is also reported to be planning the construction of a power house and dock and enlargement of its grain elevator at the same point.

The Southern Pacific Company has awarded a contract for the construction of a rail and ship terminal at Houston, Texas. The terminal will include wharves, a warehouse and several transfer sheds.

The Illinois Central Railroad has awarded a contract to Joseph E. Nelson & Sons, Chicago, Ill., for 8,000 tons of structural steel for its locomotive and car repair shops at Paducah, Ky.

The Atchison Topeka & Santa Fe Railway has awarded a contract for the construction of a tender shop at Albuquerque, N. M.

The Virginian Terminal Railway plans the construction of an office building and oil house at Sewells Point, Va.

The Atlantic Coast Line Railway plans the construction of an addition to its boiler shop at Fort Wayne, Ind.

The New York Central Railroad has purchased 180 acres of land at Nitro, West Va., and it is reported that the railway shops now located at Dickinson, West Va., will be moved to Nitro.

The Norfolk & Western Railway plans the construction of a new office building and a 24-stall roundhouse and other buildings at Portsmouth, Ohio.

The Reading Company has placed a contract covering two 10-ton ore unloading machines at Port Richmond, Pa.

The Atchison, Topeka & Santa Fe Railway has placed a contract covering the erection of a two-story recreation building at the shops at San Bernardino, Calif., to cost approximately $27,000.

The Atlantic Coast Line Railway plans the installation of an electric turntable at Thomasville, Ga., also plans extensive improvements at Savannah, Ga., to include new transfer table and a scrap reclaiming plant.

The Missouri Pacific Railroad plans the construction of a 10-stall roundhouse at Corning, Ark., to cost approximately $25,000.

The Baltimore & Ohio Railroad has awarded a contract for the construction of a locomotive stripping shed at its Mt. Clare shops to cost approximately $37,000, also for the construction of five water treating plants at Pittsburgh, Pa.

The Illinois Central Railroad has awarded a contract to Joseph E. Nelson & Sons, Chicago, Ill., for the construction of a water treating plant of 30,000 gallons per hour capacity at Sioux City, Iowa.

The Chesapeake & Ohio Railway has awarded a contract for the construction of terminal facilities, including a roundhouse, machine shop, power hour, and storage house at Russell, Ky.

The San Antonio Uvalde & Gulf Railroad plans to rebuild at once the car repair sheds at Pleasanton, Texas, which were burned recently.

The Atlantic Coast Line Railway is reported to be planning to enlarge its electric and wheel foundry and wood milling departments at Waycross, Ga., also to construct a $70,000 pumping station at that point.

The Michigan Central Railroad is reported to be considering the construction of a machine shop at Lansing, Mich.

The Minneapolis & St. Louis Railroad is reported to be making plans for the construction of shop facilities at Minneapolis, Minn.

The Atchison, Topeka & Santa Fe Railway has purchased land adjoining its property at Los Angeles, Calif., to be used in the development of a new freight terminal.

The Reading Company has awarded a contract for a 1,000 ton coaling station and sanding facilities to be erected in its engine yard at Reading, Pa. Also the company is inquiring for estimates on a freight station at Lebanon, Pa., and a machine shop at Reading, Pa.

The Chicago Burlington & Quincy R. R. has awarded a contract for the construction of grain elevator at St. Joseph, Mo., to cost approximately $200,000.

The St. Louis-Southwestern Railway are reported to have plans prepared for the construction of a machine shop addition to the roundhouse at Shreveport, La.

The Pennsylvania Railroad has awarded a contract for the completion of the railroad engine house facilities at Stony Creek, Thurlow, Pa., at an estimated cost of $100,000.

The Atchison Topeka & Santa Fe Railway plans the construction of a 12-stall reinforced concrete enginehouse, foreman office and lavatory building at Hutchinson, Kan., also for the construction of a 300-ton reinforced concrete coaling station at above place.

The Maine Central Railroad has awarded a contract for the reconstruction of a railroad car shops at Waterville, Maine, to cost approximately $32,000.

The Northern Pacific Railway are making plans for the construction of a commissary building and coach yard facilities at St. Paul, Minn.

Items of Personal Interest

R. G. Bennett, general superintendent of motive power of the Southwestern division of the Pennsylvania Railroad has been transferred to general superintendent of motive power of the Eastern division, with headquarters at Philadelphia, Pa., succeeding **J. M. Henry**, who has been appointed assistant chief of motive power.

J. C. Torpey has been appointed assistant superintendent of transportation of the Delaware & Hudson Company, with headquarters at Albany, New York.

A. C. Davis, formerly assistant chief of motive power of the Pennsylvania Railroad has been transferred to Altoona, Pa., as assistant works manager succeeding **T. B. Farrington**, who has been appointed assistant general superintendent of motive power of the new Western division, with headquarters at Chicago, Ill.

F. L. Carson, formerly mechanical superintendent of the San Antonio & Aransas Pass Railway, has been appointed assistant superintendent of motive power and equipment of the Southern Pacific lines, with headquarters at Yoakum, Texas.

H. J. McCracken has been appointed assistant master mechanic of the Western division of the Southern Pacific Company, with headquarters at West Oakland, Calif., succeeding **C. L. Gibson**, promoted.

N. P. White, master mechanic of the Minnesota division of the Northern Pacific Railway, has been transferred to the Lake Superior division, with headquarters at Duluth, Minn., succeeding **J. A. Marshall**, who has been appointed assistant master mechanic of the Fargo division, with headquarters at Staples, Minn.

J. A. Frels, formerly master mechanic of the San Antonio & Aransas Pass Railway, has been appointed master mechanic of the Southern Pacific, with headquarters at Yoakum, Texas.

Ralph Peters, Jr., has resigned as superintendent of the Long Island Railroad, with headquarters at Jamaica, New York, to become assistant vice-president of the Corn Exchange Bank. He will be succeeded by **E. B. Kessler**, assistant superintendent. Mr. Peters is the son of the late president of the Long Island Railroad.

J. H. Reisse has been appointed mechanical inspector of the Chicago, Burlington & Quincy Railroad, with headquarters at Chicago, Ill.; **E. L. Larson** has been appointed chief draftsman for car department, succeeding Mr. Reisse, and **P. N. Fox** has been appointed chief draftsman for locomotive work.

G. A. Wirch has been appointed roundhouse foreman of the Union Pacific Railroad, with headquarters at Caliente, Nev., succeeding **V. P. Yount**, promoted.

L. B. Woodward has been appointed president and general manager of the Buffalo-Union Carolina Railroad, with headquarters at Union, So. Car.

C. R. Fitch, roundhouse foreman on the Northwestern Pacific Railroad, with headquarters at Willits, Calif., has been promoted to a similar position at Sausalito, Calif.

C. O. Jenks, vice-president in charge of operation of the Great Northern Railway, has been elected also president of the St. Paul Union Depot Company, succeeding **Ralph Budd**, president of the Great Northern Railway, who has resigned.

F. E. Sumers has been appointed car foreman of the Santa Fe System, with headquarters at Waynoka, Okla., succeeding **L. R. Tibbs**, who has been appointed car foreman, with headquarters at Clovis, N. M. **F. R. Dobson** has been appointed boiler foreman, with headquarters at Calwa, Calif., and **J. F. Ohlert** has been made roundhouse foreman, with headquarters at Slaton, Texas, succeeding J. F. Foley.

W. H. Tobey has been appointed superintendent of the Smithers division of the Canadian National Railways, with headquarters at Prince Rupert, B. C., succeedingg **I. A. Macpherson**, transferred.

G. D. Hughey has been appointed superintendent of the Champlain division of the Delaware & Hudson Company, with headquarters at Plattsburgh, N. Y.

C. W. Buffington has been appointed district boiler inspector of the Chesapeake & Ohio Railway, with headquarters at Clifton Forge, Va.

W. R. Armstrong has been appointed general superintendent of the Union Pacific System, with headquarters at Los Angeles, Calif.

A. C. Harvey is appointed chief engineer of the New York, Chicago & St. Louis Railroad Company, with headquarters at Cleveland, Ohio, vice **J. K. Connor**, deceased; **J. C. Wallace** is appointed assistant chief engineer, with headquarters at Cleveland, Ohio, vice A. C. Harvey, promoted; **C. R. Wright** is appointed district engineer, Lake Erie and Western district, with headquarters at Indianapolis, Ind., vice J. C. Wallace, promoted; **W. H. Burrage** is appointed division engineer, Cleveland division, with headquarters at Cleveland, Ohio, vice C. R. Wright, promoted.

Supply Trade Notes

G. H. Webb has been appointed Philadelphia sales manager of the **Central Steel Company**, Massillon, Ohio. He succeeds **A. B. Cooper.** Mr. Webb has been identified with the Central Steel Company for more than eleven years.

The Clark Car Co., Pittsburgh, has appointed the **Engineering Products Company** as its Pacific Coast representative, with office in Rialto building, San Francisco, Calif.

William H. Reaves has been appointed southwestern sales agent for the **National Lock Washer Company**, with headquarters at 1169 Arcade building, St. Louis, Mo. Mr. Reaves was formerly connected with the Rock Island Lines, with headquarters at Little Rock, Ark.

The Thompson Electric Welding Company, Lynn, Mass., has removed its Chicago office from 817 West Washington Boulevard to 549 West Washington street; this office is in charge of **F. H. Leslie.**

W. C. Peyton, vice-president of the **Standard Stoker Company**, 350 Madison avenue, New York City, has been elected president to succeed **W. A. Larner**, who has resigned as president and a director. **A. M. Hunt** has been elected a director to succeed Mr. Larner. **H. C. Oviatt**, assistant to president, has also resigned.

The Conveyors Corporation of America has appointed **H. P. Rodgers** as their sales representative for the **American Mono-rail Cable Conveyor.** **Eugene Smith**, formerly with the **Galion Iron Works**, will be associated with Mr. Rodgers. Their headquarters will be located at Leader Building, Cleveland, Ohio.

The C. H. Hollup Corporation, located at 327 South La Salle street, Chicago, took over the sale of welding wire and accessories of the **Transportation Engineering Corporation** for the Chicago territory. The C. H. Hollup Corporation was formerly known as the International Welding Engineering Corporation. The sales manager of the C. H. Hollup Corporation is **K. R. Hare**, who was formerly district manager for the Transportation Engineering Corporation.

The Elwell Parker Electric Company, Cleveland, Ohio, has appointed the **Fuchs Equipment Company**, Omaha, Nebr., as district representative, also **The H. C. McNair Company**, St. Paul, Minn., has been appointed district representative at St. Paul, Minn.

Walter S. Carr, secretary of the Locomotive Firebox Company, was elected president to succeed the late **John N. Nicholson**, former president and founder of the company at a meeting of the board of directors, held at the offices of the company, 310 South Michigan avenue, Chicago, Ill. May 1st **Charles G. Halley** was elected secretary.

The Ingersoll Rand Company, New York, has made arrangements with **Carels Brothers**, Ghent, Belgium, by which that concern will have the right to manufacture the Ingersoll Rand solid injection type of oil engine.

The Austin Company, Cleveland, Ohio, has removed its New York City office from 217 Broadway to larger quarters at 120 Broadway. **J. K. Gannett** is district manager of the New York office; **A. D. Engle** and **D. C. Raymond** are his assistants.

W. C. Miner, general sales manager of the **Railway Service & Supply Corporation**, has removed his headquarters to Indianapolis, Ind., and the Chicago office has been closed.

The Brinard Sales & Construction Company, Inc., has recently been formed with offices at 441 Lexington avenue, New York, N. Y. This company will engage in the construction of railroad devices. The officers are **Mark R. Briney**, president; **John J. Hubbard**, vice-president, and **Edward Shannahan**, secretary.

A. M. Ripley has been appointed to the railway signal sales department of the **Electric Storage Battery Company**, Philadelphia, Pa., with headquarters at Chicago, Ill.

Joseph J. McGarrigle has been appointed eastern manager of the **Clark Car Company**, succeeding **B. K. Mould**, resigned. Mr. McGarrigle's headquarters are at 52 Vanderbilt avenue, New York.

The Eastern Car & Construction Company, Kansas City, Mo., has been incorporated to build railroad equipment by **Thomas R. Hunt** and **E. S. North**, with headquarters at 1127 Scarritt Building, Kansas City, Mo.

The Pennsylvania Car Company plans the construction of a new structural steel fabricating plant at Beaumont, Texas, to cost approximately $90,000.

B. H. Sullivan has resigned as chairman of the board of directors of the **Independent Pneumatic Tool Company**, Chicago, Ill., and **John A. McCormick** has been elected to succeed him.

W. F. Barrett received the honorary degree of doctor of science from the University of Pittsburgh recently, in recognition of his achievements in the production and commercialization of industrial gases. Mr. Barrett is vice-president and a director of the **Linde Air Products Company**, president of the **Dominion Oxygen Company, Ltd.**, vice-president and a director of the **Prest-O-Lite Company, Inc.**, and a director of the **National Carbon Company, Inc.**, all companies affiliated together in the **Union Carbide & Carbon Corporation.** He is also vice-president of both the **Union Carbide & Carbon Research Laboratories** and the **Carbide & Chemicals Corporations.**

The Linde Air Products Company, New York, countrywide manufacturer and distributor of oxygen for welding and cutting, has recently opened the following new district sales offices: 716 First National Soo Line Building, Minneapolis, Minn.; C. E. Donegan, district sales manager, 409 Lincoln Life Building, Birmingham, Ala.; W. A. J. Kopp, district sales manager, 508 Exchange National Bank Building, Tulsa, Okla.; G. D. Brubb, district sales manager. Local oxygen sales activity and the extension of Linde Process Service for Linde Oxygen customers, as well as the sale of Prest-O-Lite dissolved acetylene will be handled by these offices for their respective territories.

The Linde Company also announces the appointment of **J. W. Foster** as district sales manager at Baltimore. Prior to this appointment Mr. Foster was a senior salesman in the Pittsburgh Linde district.

George T. Willard, formerly connected with **The Rail Joint Company**, is now connected with sales force of **The Railroad Supply Company**, with headquarters at Chicago, Ill.

The Conley Tank Car Company have moved its general offices to the Olive Building, Pittsburgh, Pa.

The Davis Equipment Company has removed its offices from 50 Church street, New York, to 80 West 40th street, New York City.

The Page Steel & Wire Company announce the appointment of **J. J. Flaherty**, formerly in charge of welding for the Boston Elevated Railway Company, in connection with the sale of Armco welding wire. It is also reported that a welding service department has been established to handle welding problems.

The Union Simplex Train Control Company, Inc., has been formed and has recently taken over the entire assets, including patents both foreign and domestic, of the **Simplex Train Control Company, Inc.**, of Rochester, New York.

The Timken Roller Bearing Company, Canton, Ohio, has purchased the **Gilliam Manufacturing Company**, and the production of Timken bearings and Gilliam bearings will be continued in the respective plants.

Jenkins Brothers, 80 White street, New York City, has secured the ownership and good will of **H. A. Rogers Company**, New York.

The Locomotive Stoker Company has acquired the **Elvin Mechanical Stoker Company**, the exclusive patent rights covering the Elvin shovel type stokers heretofore sold by that company. They are now in a position to supply either the duplex or the shovel type as may be preferred.

Obituary

August Kreusi, former engineer of construction of the General Electric Co., died on May 7 at El Paso, Texas. He had been on leave of absence since 1921, and resigned two years ago because of ill health. Mr. Kreusi was graduated from Union College in 1898, and from that time until 1900 was with the British Thompson-Houston Company in London. During the next two years he worked on electrical machine design for the General Electric Co. at Schenectady. From 1902 to 1906 he was engaged in the commercial development of the Curtis steam turbine, and from then until 1908 was in the railway engineering department, working on powerhouse and substation design. Mr. Kreusi was made head of the construction engineering department when it was established in 1908, and continued in that position until he obtained a leave of absence in 1921. When he resigned in 1923, he continued his work with the company in a consulting capacity. Mr. Kreusi was a son of John Kreusi, who was manager of what is now the Schenectady Works of the General Electric Co.

J. K. Conner, chief engineer of the Nickel Plate and the Lake Erie and Western districts of the New York, Chicago & St. Louis Ry., with headquarters at Cleveland, Ohio, died at Wabash, Ind., on May 18. Mr. Conner was born on April 12, 1871, at Wabash and graduated from the Rose polytecnic institute in 1891. He entered railway service on June 15, 1895, as assistant engineer of the Cleveland, Cincinnati, Chicago & St. Louis Railway, being promoted to supervisor of track on January 1, 1899. Mr. Conner was appointed assistant engineer of the Baltimore & Ohio R. R. on July 26, 1899, and on April 1, 1900, he was appointed assistant engineer of the New York Central & Hudson River Railroad. On April 1, 1901, he was appointed designer and draftsman in the bridge department of the Lake Shore & Michigan Southern Railway, and on February 17, 1903, he was appointed engineer of the Chicago & Southeastern Railway. On March 28, 1903, he was appointed division engineer of the Lake Erie Alliance & Wheeling Railroad, and on September 20, 1905, assistant engineer of the Lake Shore & Michigan Southern Railway. On April 1, 1906, he was appointed first assistant engineer of the Lake Erie & Western Railroad, and on February 10, 1924, he was promoted to chief engineer of that line. In September, 1924, he was appointed chief engineer of the New York, Chicago & St. Louis Railroad, succeeding E. E. Hart, in which capacity he was serving at the time of his death.

George D. Pugh, superintendent of the Atlantic Coast Line Railway, with headquarters at Savannah, Ga., died at Jesup, Ga., from heart failure. Mr. Pugh has been in the service of the Atlantic Coast Line Railway for 37 years. He was born in Wilmington, N. C., in 1863. He formerly was conductor, trainmaster, and later superintendent of the Columbia division, with headquarters at Florence, S. C. He was transferred to Charleston, S. C., as superintendent of the Charleston division and in 1907 he was appointed superintendent of the Savannah division, with headquarters at Savannah, Ga. in which capacity he was serving at the time of his death.

William W. Wood died recently at Lafayette, Ind. Mr. Wood was a well known authority on railway brakes. Mr. Wood was an air brake instructor on the Chicago, Indianapolis & Louisville Railroad for many years and was the author of text books on Locomotive Breakdowns, The Walschaert Locomotive Valve Gear and Wood's E. T. Air Brake Pocket Book which are all published by Norman W. Henley Publishing Co., 2 West 45th street, New York City.

New Publications

Books, Bulletins, Catalogues, etc.

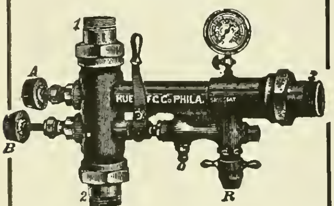
Railway & Locomotive Historical Society. Another interesting bulletin, No. 9, has been issued by this society. The feature article deals with the history of the Portland Company, Portland, Maine, which was engaged in locomotive construction for many years. In 1852 it built the first locomotives for the Panama Railroad, and while it has built no locomotives since 1907, it still flourishes in other lines. Much other railway historical information is contained in this and other bulletins of the society, and we suggest that those interested in such matters communicate with the secretary, addressing the society at 6 Orkney Road, Brookline, Mass.

Auxiliary Locomotives. The Bethlehem Steel Co., Bethlehem, Pa., has issued catalogue H, descriptive of the operation, principal details and performance of the Bethlehem auxiliary locomotive. This is the four-wheeled tender-truck booster which was developed on the Delaware & Hudson Co. The catalog contains illustrations showing the design and construction of the tender-booster with data in regard to its performance and operation.

The Advantages of Buying Renewal Parts From the Manufacturer Most Interested in Their Performance. The Westinghouse Electric & Manufacturing Co., has reprinted a paper of the foregoing title, which was presented at the annual meeting of the Pennsylvania Street Railway Association, by H. R. Meyer.

The purpose of Mr. Meyer's paper was to present some ideas that would help to further decrease maintenance costs and at the same time secure more realiable performance as well as bringing about a general lowering of first cost of renewal parts and the original equipments. Throughout the paper Mr. Meyer has discussed briefly such points as the economies of the subject involved, quantity manufacture, tool requirements, engineering research in materials, maintenance men as manufacturers, machine tolerances and fits, overstocking due to internal manufacture and service in their relation to renewal parts.

Copies may be obtained from any district office or from the Department of Publicity at East Pittsburgh by asking for Reprint 221.



Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXVIII 114 Liberty Street, New York, July, 1925 No. 7

Test of the Missouri Pacific Three-Cylinder Mikado

An Interesting Comparison Between It and a Two-Cylinder Mikado Locomotive of the Same Weight

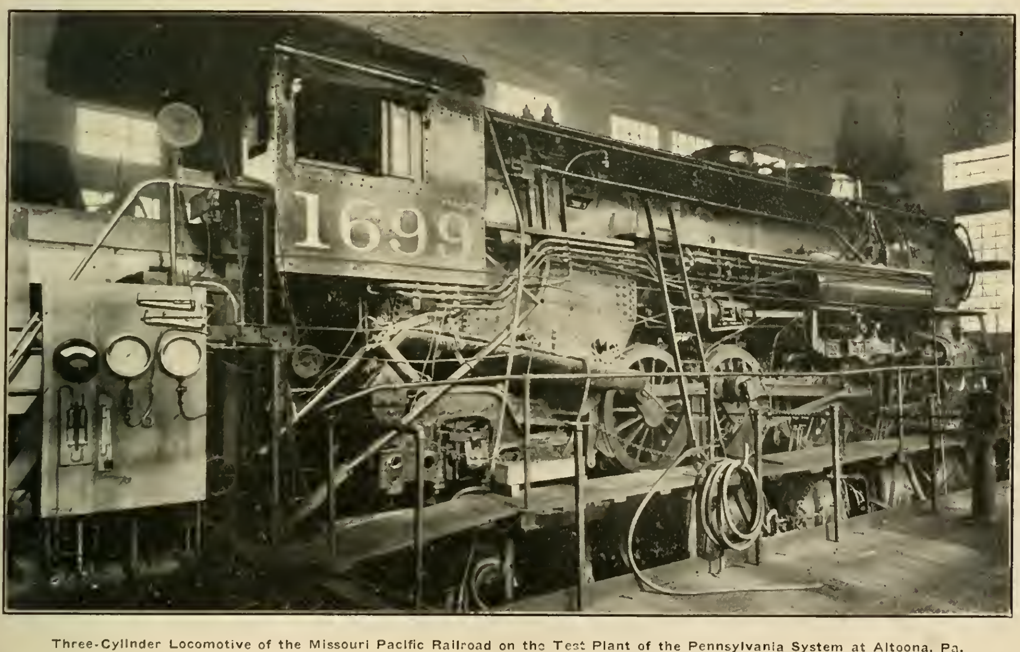
Among the three cylinder engines recently built by the American Locomotive Company, was a Mikado 2-8-2 type for the Missouri Pacific Railroad, which upon completion was sent to the test plant of the Pennsylvania Railroad at Altoona, Pa., where it was submitted to a thorough test. Since this is the first three cylinder locomotive to be so tested, the general results obtained and here embodied will be of interest, especially as the results are compared with those obtained with the Pennsylvania Mikado.

The locomotive weighs 340,000 lb. of which 244,500 lb. is on the drivers. The calculated tractive force is 65,700 lb. at starting. The two outside cylinders are 23 in. by 32 in., and the inside cylinder is 23 in. by 28 in. The boiler pressure is 200 lb. per sq. in.

The boiler is fitted with an Elvin stoker, a Nicholson syphon and a Harter circulator.

In the diagrams that are presented a comparison is made between the two Mikados, the Pennsylvania two-cylinder and the Missouri Pacific three-cylinder engines. This is done because among the locomotives for which data have been obtained at the test plant, it most nearly resembles this Missouri Pacific locomotive. In fact, in several particulars, as will be seen by a reference to the table the two locomotives are very nearly of the same size and capacity. The weight on drivers of the 1699 is but 4,300 lb. greater than the corresponding weight of the L1s, and the total heating surface differs by only 50 sq. ft. The Pennsylvania Mikado or Class L1s, however, cannot be considered modern, as it was designed over ten years ago.

The coal was the same as that generally used at the test plant as a standard for freight locomotive tests. It

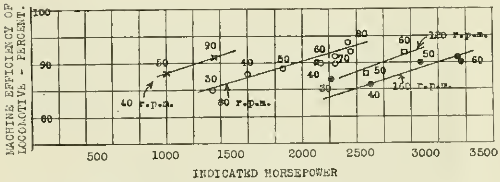


Three-Cylinder Locomotive of the Missouri Pacific Railroad on the Test Plant of the Pennsylvania System at Altoona, Pa.

is a Pennsylvania bituminous coal from the Crows Nest mine of the Keystone Coal & Coke Company near Harpfield Station on the main line of the Pennsylvania Railroad, in the Greensburg district. It is a Pittsburg seam coal, medium hard and semi-blocky. It was in run of mine size, and, while about 30 per cent of it will not go through a screen having 4 in. round openings, it contains small sizes, so that three per cent of it will go through a screen having 1/16 in. round openings.

As received at the test plant, the locomotive was difficult to fire, and appeared to have insufficient draft. From her similarity to the Pennsylvania Mikado, it was believed that with proper combustion an evaporation as high as 59,000 lb. of water per hour, or about 12 lb. per sq. ft. of total heating surface, could be reached. In order to determine this by actual test, a run was made at 160 r.m.p. and 50 per cent cut-off, and wide open throttle, as soon as the locomotive had been operated on the plant enough to make such a heavy load feasible. The result was an evaporation of only 48,000 lb. per hour, or about 10 lb. per sq. ft. of total heating surface. The draft in the smokebox was 9 in. of water. Measurements of the velocity head of the smokebox gases at the top of the stack showed all positive pressures, and as much as ten or eleven inches of water at the edges.

The stack of No. 1699 has a diameter of about 19 in. at the top, tapering to 18 in. near the top of the smokebox,



Machine Efficiency of Three-Cylinder Locomotive Showing Efficiency of the Engine Only at Various Indicated Horsepowers

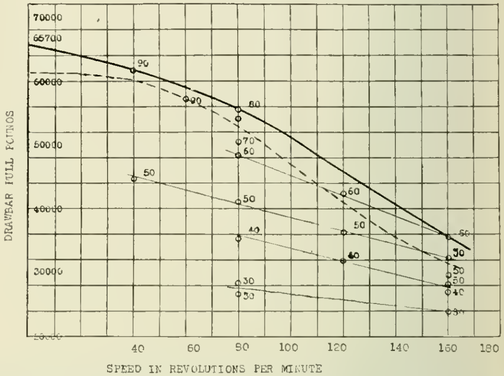
and then tapering out to a much larger diameter at the lower end, which is about 2 ft. 5 in. above the exhaust nozzle.

For the purpose of improving the draft conditions, a basket bridge was fitted to the exhaust nozzle, the inside diameter of the tip was increased to 6½ in. and the stack was fitted with an extension, whose lower end was about 15 in. above the nozzle. Trials with this arrangement showed little improvement in the strength of the draft.

On account of the similarity of the boiler of No. 1699 to that of the Pennsylvania Mikado, it was thought that the essential features of the latter's front end, that is, its arrangement of stack and nozzle, might enable No. 1699 to steam properly. The Pennsylvania engine's stack has a diameter of 17 in. at the base and tapers uniformly to the top where the diameter is 24 in. resulting in an area at the top about 50 per cent greater than in the original stack of No. 1699. After this stack, which was found to fit the front end arrangements of this locomotive, had been applied, and with the same 6½ in. exhaust nozzle, with basket bridge, a test at 160 r.p.m. and 50 per cent cut off, showed the limit of the boiler to have been reached at an evaporation of 46,440 lb. per hour. The pressures at the top rim of the stack were small and most of them negative, indicating a vacuum of 4 to 7 in. of water, which showed that the stack was not filled.

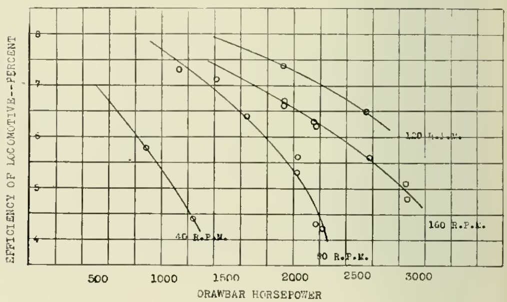
The exhaust nozzle was then increased in diameter to 7 in. retaining the basket bridge, after which an evaporation of 55 700 lb. per hour was obtained. In this test, the safety valve opened, and the locomotive began to draw water from the boiler through the throttle valve. On account of moisture in the steam its temperature fell from 630 deg. F., to the temperature of saturated steam corresponding to the observed branch pipe pressure. This locomotive does not have a plate under the safety valves as in Pennsylvania practice. Such a plate would appear to be of value in preventing a direct flow of steam to those valves, which are almost directly over the syphons in the firebox.

Notwithstanding the improvements resulting from the



Drawbar Pull at Various Speeds with a Comparison Between the Three-Cylinder and Two-Cylinder Locomotives—Dotted Lines Indicate Two-Cylinder Locomotive—Full Lines the Three-Cylinder Locomotive

changes just described, the firing on heavy load tests was still difficult and the locomotive did not steam freely. Finally, the basket bridge was removed and Goodfellow projections were added to the 7 in. diameter nozzle, and this, with the stack of the Pennsylvania Mikado was found to make the steaming and draft conditions very satisfactory. It was now found possible to reach an evaporation of 59,990 lb. per hour and later, 61,680 lb. The latter figure corresponds to 12.6 lb. per sq. ft. of heating surface per hour.



Overall Efficiency of the Three-Cylinder Locomotive at Various Speeds and Loads

After the regular tests of No. 1699 were completed, its orginal stack, but this time without petticoat pipe, was reapplied. The 7 in. diameter nozzle with Goodfellow projections, was left in. With this arrangement the locomotive did not steam properly even at rates of evaporation as low as 47,553 lb. per hour.

In the following table is shown the weight of locomotive per horsepower developed. The three cylinder and the L1s design are about alike in this comparison. The

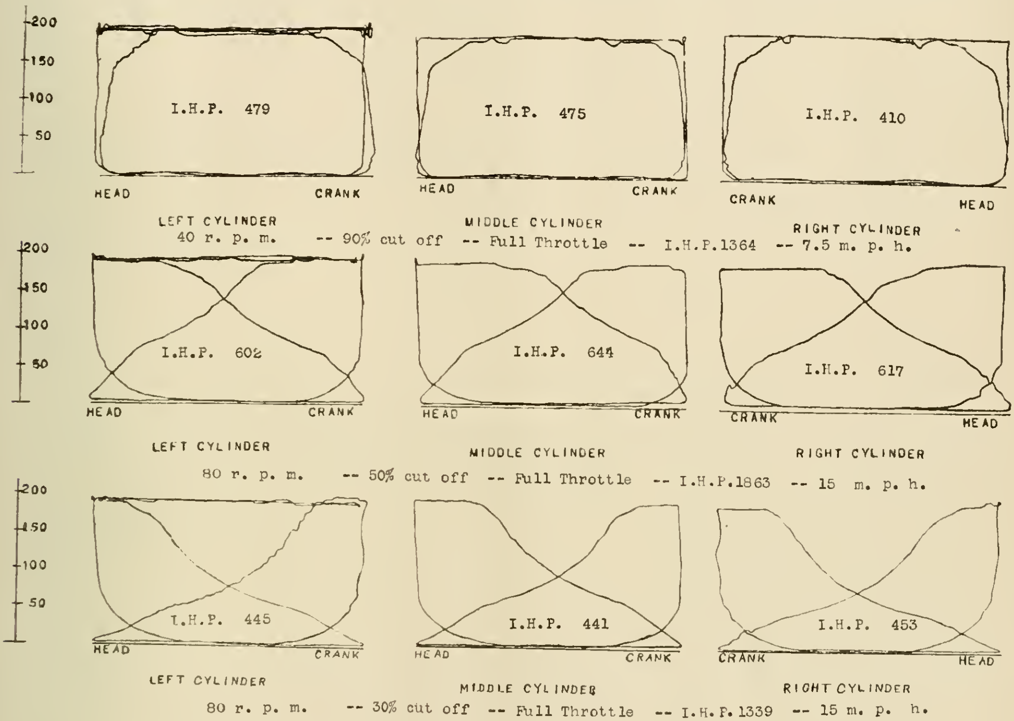
2-10-0 or class Ils, with high steam pressure, and large cylinders, has much less weight than the other two locomotives per unit of power developed.

Locomotive	Missouri Pacific No. 1699	P. R. R. Lls	P. R. R. Ils
Weight of locomotive in working order, lb.	340,000	320,700	386,100
Maximum indicated horsepower	3176	2954	3863
Maximum drawbar horsepower	2863	2700	3334
Wt. of loco. per indicated horsepower	107.1	108.6	99.9
Wt. of loco. per drawbar horsepower	118.8	118.8	115.8

speeds, the variation in drawbar pull was less for the three-cylinder engine.

Without any very definite information in regard to the exact speed where vibration becomes destructive on the test plant, it appears probable that without special balancing the two cylinder locomotives can be safely operated at 180 r.p.m. and the three cylinder at 240 r.p.m., or at a speed approximately one-third higher.

No measurements were made of the turning moment or torque, due to the three cylinder arrangement, as compared with the usual two cylinder arrangement.



Indicator Diagrams from Three-Cylinder Mikado Type Locomotive of Missouri Pacific Railroad

With two cylinder locomotives, it has been found, on the test plant, that the fore and aft motion, or vibration due to unbalanced reciprocating parts, becomes so severe at a speed above 200 r.p.m., that additional balance weights are needed in the wheels for test plant operations, and it is customary to add sufficient weights to completely balance all of the reciprocating weights.

With this three cylinder locomotive, no additional balance weights were applied, and a speed of 235 r.p.m., was reached before the fore and aft vibration became violent enough to endanger the mechanism of the dynamometer. A drawbar pull line drawn by the dynamometer open at a speed of 200 r.p.m., and increasing up to 235 r.p.m., shows a vibration increasing in range from between about 19,000 lbs. and 22,000 lbs. to a range between 16,000 lbs. and 23,000 lbs. or an increase of more than 2 to 1 in the amplitude of the vibrations. Comparative drawbar pull lines for the two cylinder Lls and the three cylinder locomotive show that, for the same speeds, the vibrations of the two cylinder locomotive have about twice the amplitude of those of the three-cylinder. In fact, at all

Referring to the diagrams that are shown herewith, there is one showing the percentage of the efficiency of the machine portion of the locomotive. These efficiencies increase with the horsepower developed and the increase in the length of the cutoff in nearly straight lines and ranged from about 85 to about 95 per cent.

On the other hand the efficiency of the locomotive as a whole fell off with the increase in speed and the horsepower developed.

In the diagram showing the drawbar horsepower on the basis of revolutions of the driving wheels per minute, the dotted line shows the development of the two-cylinder locomotive under the same conditions as the upper line of the three-cylinder machine. According to these lines the drawbar pull of the three-cylinder machine was about 5,000 lbs. more than that of the two-cylinder at all speeds.

The indicator cards that have been selected for illustration are taken from the three-cylinder machine at speeds of 7.5 and 15 miles per hour and with a cut-off for the lower speed of 90 per cent and for the other two at 50 and 30 per cent respectively. These show some variation in the indicated horsepower developed in the different cylinders. The following tabulation shows that variation.

Cylinder	Per Cent of Cut-off		
	90	50	30
Left	479	602	445
Right	475	644	441
Middle	410	617	453
Total	1364	1863	1339

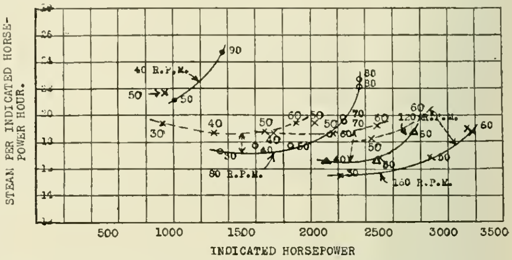
The following table gives the principle dimensions of the locomotive listed beside two Pennsylvania locomotives of the 2-8-2 and 2-10-0 types respectively.

GENERAL DIMENSIONS

Type	2-8-2	2-8-2	2-10-0
Class and Railroad	Missouri Pacific	P R. R.	P. R.R.
Number	1699	1752	4358
Year built	1925	1914	1923
Weight in working order, lb.	340,000	320,700	386,100
Weight on drivers, lb.	244,500	240,200	352,500
Weight of engine & tender in working order, lb.	530,100	497,050	590,900
Tractive Force (Calculated) lb.	65,700	61,465	90,024
Tractive Force per lb. m. e. p.	386	353	480
Driving Wheels, diameter, in.	63	62	62
Wheel Base, driving, ft. & in.	17-10	17½	22-8
Wheel base, total, ft. & in.	37-5	36-4½	32-2
Wheel base, engine & tender, ft. & in.	72-3½	73-3½	73½
Cylinders, outside diam. & stroke in.	23x32	27x30	30½x32
Cylinders, middle diam. & stroke in	23x28	....	....
Piston displacement (total) cu. ft.	22.1	19.9	27.1
Valves (piston) diam. in.	....	....	....
Valve gear, type	Baker	Walschaerts	Walschaerts
Boiler pressure, lb. per sq. in.	200	205	250
Firebox, type	Straight top	Belpaire	Belpaire
Grate area, sq. ft.	66.3	70	70
Small flues, No.	199	236	114
Small flues, outside diam. in.	2.25	2.25	2.25
Large flues (four superheater) no.	45	40	200
Large flues, outside diam. in.	5.5	5.5	3.25
Flues, length, in.	228	228	228
Heating surface, flues (fireside) sq. ft.	3110	3373	4104
Heating surface, firebox (fireside) (including arch pipes & syphons) sq. ft.	366	305	287
Evaporative heating surface (fireside) sq. ft.	3476	3678	4391
Superheating surface (fireside) sq. ft.	1367	1215	2410
Heating surface, total (fireside) sq. ft.	4843	4893	6801
Feedwater heater	None	None	Worthington
Stoker	Elvin	None	Duplex
Water space in boiler cu. ft.	683	572	601
Steam space in boiler cu. ft.	108	127	123
Steam space in percentage of total boiler volume	14	18	17
Ratios			
Weight on drivers (5-B) to tractive force (3)	3.7	3.9	3.9
Total heating surface (11) to grate area (7)	73.0	69.9	97.1
Flue surface (11a) to firebox surface (11b)	8.5	11.1	14.3
Superheating surface (11c) to evaporating heating surface	0.39	0.35	0.33

The diagram showing the steam consumption per indicated horsepower is particularly interesting as it gives a comparison between the two and three cylinder engines. In this diagram the consumption of the three-cylinder is shown by the full lines and that of the two-cylinder by the dotted lines. The speed in revolutions per minute is shown by a reference arrow leading to each of the full line curves and the dotted line curves are connected to their mates by an arrowed dotted line. The figures annexed to the several points indicate the points of cut-off for the points referred to. The significant point is that, in every case the steam consumption for the two-cylinder locomotive is more than for the three. And sometimes by a very considerable percentage. This advantage of the three-cylinder machine increases with the increase of speed.

The conclusion reached by the engineer of tests re-



Comparison of Steam Consumption Per Indicated Horsepower at Various Speeds and Loads Between Three-Cylinder Engine and Two-Cylinder Engine—Full Lines Indicate Three-Cylinder Engine —Dotted Lines Two-Cylinder Engine—Small Figures Denote Cut-off

porting on the performance of the engine is that performance on the test plant indicates an efficient design of both engines and boiler with the exception of the front end arrangement.

Centennial Celebration of First Passenger Train

The one hundredth anniversary of the world's first passenger train was celebrated July 1 at Darlington, England, by an exhibition of locomotives, rolling stock and other equipment showing the development of railway transportation during the past century.

Although the first passenger train was put in service between Darlington and Stockton on September 27, 1825, the celebration took place in July to permit the members of the International Railway Congress which met in London last month, to attend.

Besides the exhibition of equipment and other ceremonies at Darlington there was a procession over the old Stockton and Darlington route in which "Locomotion No. 1," built by George Stephenson, hauled a replica of the original train and carrying 450 passengers over the 26-mile route it traveled in 1825. Another spectacular item in the procesion was a train composed of wagons, on which various historical railway tableaux was presented.

Large Fuel Saving Effected This Year

Class I railways in March consumed 8,149,802 tons of coal as fuel for road locomotives in freight and passenger train service charged to operating expenses, as compared with 9,047,802 tons in March last year; at an average cost of $2.82 a ton as compared with $3.24 last year, according to the Interstate Commerce Commission's monthly statement.

The total cost was $23,008,110, as compared with $29,-343,077 last March.

The cost per ton ranged from $1.88 in the Pocahontas region to $4.79 in the New England region.

The roads also consumed 169,236,412 gallons of fuel oil, at 3.21 cents per gallon, as compared with 179,290,228 gallons at 2.77 cents in March, 1924.

For three months this year the cost of coal was $71,-427,433, as against $89,198,992 last year and the total cost of coal and fuel oil was $87,104,196, as compared with $103,210,430 last year.

Mechanical Division Meeting of A. R. A.

Abstracts of Some of the Reports Presented at Chicago Meeting

The annual meeting of the Mechanical Division, American Railway Association, was held at the Hotel Drake, Chicago, Ill., June 16, 17 and 18. J. J. Tatum, superintendent, car department, Baltimore & Ohio Railroad, chairman of the Division, presided.

In accordance with the decision to hold meetings with exhibits only every other year, the annual meeting this year was a strictly business meeting without exhibits of machinery and devices. However, a small exhibit of equipment was arranged by the railroads in the yards of the Illinois Central. This consisted of box cars built to the design of the Committee on Car Construction, and including the single sheathed car adopted as recommended practice, the double sheathed wooden sheathed box car now being recommended for adoption as recommended practice by the same committee, and the all steel box car built to design prepared by the Committee two years ago.

In addition to these cars several modern locomotives were exhibited by their railroad owners.

R. H. Aishton, president, American Railway Association addressed the opening session, following which the reports of the various committees and individual papers were dealt with.

The membership of the Division at the present time includes 208 railways, representing 399 memberships in the American Railway Association, and in addition thereto, 190 railroads, associate members of the American Railway Association. These railroads, members and associate members of the American Railway Association, have appointed 999 representatives in the Mechanical Division. In addition there are 1,065 affiliated members and 142 life members in the Division.

In this and the following pages is presented abstracts from some of the Committee reports.

Locomotive Design and Construction

This report consists of a series of practically independent reports on the following subjects:

Comparative Merits of Hydrostatic and Force Feed Lubrication for Locomotive Cylinders and Steam Chests and Best Methods of Application;

Standardization of Taps and Dies Used by Railroads, Bolt and Screw Thread Standardization;

Definition of an Engine Failure;

Standardization of Water Columns;

Removable Hand Rail Columns;

Locomotive Development.

This last was divided into two parts: The Steam Locomotive and the Internal Combustion Locomotive.

Hydrostatic and Force Feed Lubrication

That there has been considerable interest manifested in the process of force feed lubrication of locomotive valves and cylinders is evidenced by the number of roads that have force feed lubricators in use, either experimentally or established as a practical system. Inquiries sent to the manufacturers of locomotive force feed lubricators requesting a statement as to the number of lubricators in service or on order as of March 1, 1925, developed that there are now in service, or on order, force feed lubricators of the various types, as follows:

Nathan Mfg. Co.	386
United States Metallic Packing Co.} (McCord)	694
Formerly Loco. Lubricator Co.} (Schlacks)	1308
Edna Brass Mfg. Co.	36
Madison-Kipp Corp. (Information not available)	
	2,424

These lubricators are distributed over quite a wide range including 76 railroads and 13 logging or commercial plants owning locomotives.

The expressions received from the various railroads using force feed lubricators indicate that this method of lubrication is exciting considerable interest, and is establishing a favorable impression. Only in a very limited degree was any expression adverse to force feed lubrication received.

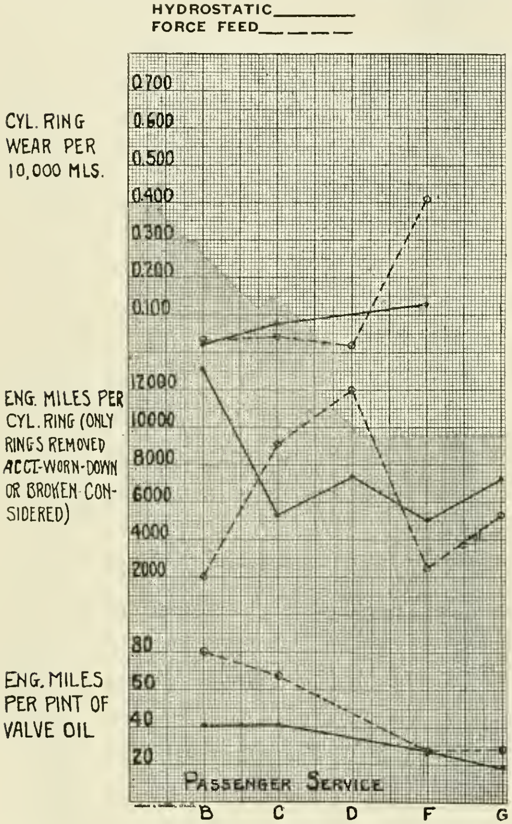
There is a total of seven roads that co-operated with your Committee in the pursuit of this subject and have furnished the results of their observations. The reports from these seven roads embrace the comparative performance of hydrostatic versus force feed lubrication on a total of 22 locomotives. With the exception of four, these locomotives were equipped with hydrostatic oil delivery to one side and force delivery to the opposite side.

In preparing the table showing the relative results obtained from the two systems of lubrication, the record as obtained in passenger and freight and locomotive service has been separated according to the class of service, following which a combination of the results, including both passenger and freight service, is shown. There were 14 passenger locomotives under observation, during which time 38 valve rings in the hydrostatically lubricated positions, and 45 in the force feed lubricated positions were removed on account of being worn, broken or down. From these valve rings an average service of 13,471 miles was obtained with hydrostatic lubrication, and 11,749 miles with force feed lubrication. From these same locomotives there was a total of 72 and 104 cylinder packing rings removed from the hydrostatic and force feed positions respectively. The average mileage per cylinder ring was 7,600 for the hydrostatic, and 6,550 for the force feed. A representative number of rings removed were measured for radial wear at five equally spaced points around the ring from the ends, and from the mileage performance record of these rings the average rate of wear per 10,000 miles has been determined, which, for the hydrostatic lubrication, was .027 inches; force feed lubrication .029 inches, the rate of wear was practically equal. Comparing the mileage made per pint of oil there is a marked difference favorable to force feed lubrication since an average of 50.6 miles per pint of oil was secured as against 30.5 miles for the hydrostatic. Attention is called, however, to the wide range in the oil consumption figures as indicated by the maximum and minimum results. With hydrostatic lubrication the maximum and minimum mileage per pint was 49.1 to 15.9 miles respectively, while with the force feed lubricator the range was from 101.8 to 21.4 miles respectively.

In freight service there was a total of eight locomotives under observation. The performance of the valve packing rings was not sufficiently complete to enter into the comparison. Considering the cylinder packing rings there was a total of 22 removed from the hydrostatic and 25 from the force feed positions. The average mileage made by these packing rings was 1,954 and 2,600 for the hydrostatic and force feed lubricators respectively. Comparing the performance on the basis of the average radial ring wear per 10,000 miles, the record shows a rate of .239 inches and .197 inches for hydrostatic and force feed lubrication respectively. The mileage per pint of valve oil in freight service was favorable to the hydrostatic lubrication, 32 miles having been realized as against 26.7 for force feed lubrication. It is necessary to call attention to these individual values established in the comparison of the two methods of lubrication in order that a comprehensive idea of the results of this study as a whole may be obtained.

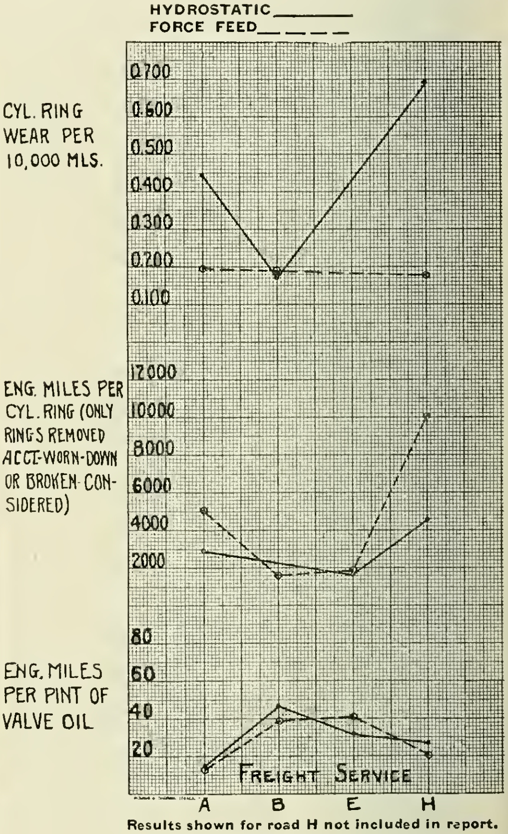
In passenger service a difference of 13.8 per cent in cylinder packing ring service in favor of hydrostatic lubrication is shown, while in freight service a difference of 33 per cent favorable to force feed lubrication is recorded. On the basis of radial cylinder packing ring wear per 10,000 miles service, the results from the two systems of lubrication are practically equal in passenger service, while in freight service a difference of 17.6 per cent is shown favorable to force feed lubrication. Considering the mileage obtained per pint of valve oil, a difference of 65.9 per cent favorable to force feed lubrication in passenger service is shown, while in freight service the difference is 16.6 per cent, favorable to hydrostatic lubrication.

Attention has already been called to the wide range in the values of the same items obtained from different roads. To better illustrate this, a graphic chart has been prepared, identified as Fig. No. 1. On this chart is shown the values of certain items as established on the various roads contributing to the investigation of this subject. In the vertical scale are the items under consideration, while in the horizontal scale the letters indicate the different roads where these values were established. The results obtained in passenger and freight service are shown separately.



NOTE.—Roads submitting data indicated by letters A-B-C etc.

Fig. 1



Results shown for road H not included in report.
NOTE.—Roads submitting data indicated by letters A-B-C etc.

Fig. 1-A

In the consideration of the performance record to which reference has just been made, no striking difference between the two systems of lubrication from any basis of comparison carries through both freight and passenger service. In passenger service a better valve and cylinder packing ring performance was obtained from hydrostatic lubrication, while a better mileage performance per pint of valve oil was secured from force feed system. In freight service a better cylinder packing ring performance was obtained from the force feed system, while a better mileage performance per pint of valve oil was obtained from the hydrostatic system. While there may be a slight difference favorable to force feed lubrication as against hydrostatic system, the difference is not striking or particularly conclusive.

As previously mentioned, some very enthusiastic expressions were received from roads using or experimenting with force feed lubrication, but in the consideration and analysis of the concrete data furnished your Committee covering the performance record obtained from the two systems of lubrication the results obtained from force feed lubrication do not stand out in strong contrast with those obtained from the hydrostatic. There may be those who are strong advocates of either system of lubrication who may feel disposed to challenge the results presented, and the position they assume may be the result of observations of individual comparisons where the differences were strikingly established, but considering 22 locomotives operating on seven different roads, the results obtained do not strongly support one system of lubrication in preference to another.

There is unquestionably a strong tendency developing towards force feed lubrication, and it is the opinion of your Committee that this tendency is in the line of progress. It may not be amiss in this connection to mention a few of these more pertinent items that should be given consideration in the installation of force feed lubricators:

The lubricator should be firmly supported by being bracketed, preferably to the cylinder casting, and should be located so it will be readily accessible for filling and for such attention as to adjustment of feeds as may be necessary. In all installations the piping leading from the lubricators to the point of delivery should be as short as possible and secured to some rigid portion of the locomotive, such as following along the frame construction or bracketed to the cylinder casting. Encasing the tubing in electric loom provides some protection against changes in atmospheric temperature.

In order that the oil feed may be in direct proportion to the piston travel regardless of the position of the reverse bar it is recommended that the lubricator be actuated by connection with the valve motion link or other positive travel location.

It might be well to recognize certain features of the force feed lubricator that are considered desirable. Suitable means for controlling the temperature of the oil in the lubricator should be provided. If the temperature of the oil is too low, delivery will be retarded. If too much steam for heating the oil reservoir is turned on, the oil will eventually boil over with resultant waste. Provision should be made for individual feed adjustment, since in some installations where oil is delivered to both valves and cylinders it is desirable to have some method of adjustment of the oil feed so that each individual delivery can be adjusted to the amount of oil required for that particular position.

After careful consideration of all the information collected in the study of the subject of hydrostatic and force feed lubrication of locomotive valves and cylinders it is the thought of your Committee that this is a subject for which no general rule or recommendation can consistently apply. The conclusion therefore reached is that on account of local influence or existing conditions on different roads the solution as to whether hydrostatic or force lubrication will meet conditions to the better advancement of economy and service will have to be worked out by individual roads having the subject under consideration.

Standardization of Taps and Dies and Bolt and Screw Threads

This Committee has no comment or criticism to offer with respect to the standards, already adopted by the Association, except to suggest that in view of the disposition of the railroads and the Association to adopt screw threads which do not conform to the Sellers or U. S. Standard tables, particularly for special purposes, such as boiler work, pipe work, injector couplings, etc., the statement on page L-27 of the Manual, to the effect that "The Sellers or Franklin Institute System of screw threads is the standard of the Association" should be qualified so as to avoid conflict between this statement and other standards and recommended practices which have been, or may be adopted.

The Committee feels that in the case of thin castle nuts, whose use, insofar as locomotives are concerned, is confined almost exclusively to crank pins, knuckle pins, crosshead pins, piston rods, etc., the form and number of threads per inch in the nuts should be governed by the threading of the parts to which they are applied.

The Committee also feels that the form of threads to be used for lubricator fittings should be definitely specified.

Attention has been called by the Committee on Locomotive and Car Lighting to the fact that the Association has no standards for bolts or machine screws smaller than ¼-in. diameter, which is the smallest size included in the Sellers or U. S. Standard tables. This Committee has therefore undertaken the work of ascertaining the present practices of the various roads with regard to sizes and threading of machine screws.

Information has been received from twenty roads. Fifteen report having no standards of their own, but are either following, or recommend following, the A. S. M. E. standards. Three have adopted as standard a certain number of sizes which are included in the A. S. M. E. standards, but have not adopted the entire A. S. M. E. table. Two roads report having standards of their own which do not agree with the sizes and threading found in the A. S. M. E. tables.

In view of the predominance of the A. S. M. E. sizes, it seems proper that the sizes and threads that are adopted for machine screws should be selected from the A. S. M. E. tables. Attention is called to the fact that the A. S. M. E. tables include screws up to, and including .45 inches diameter, thereby including some sizes which are practically the same, as regards diameter, as sizes included in the U. S. Standard table, but in all cases the A. S. M. E. threading differs from the threading of corresponding sizes shown in the U. S. S. table. We therefore recommend adoption of certain A. S. M. E. sizes of machine screws as shown in Table 1.

The A. S. M. E. standards include five styles of heads for machine screws, some of which have obviously been designed to present an elegant appearance. For locomotive use, the Committee recommends consideration of only three styles of heads, viz.:

The Flat or countersunk head, Round or button head, Flat fillister head.

The Flat fillister head, last mentioned, may be either round or hexagonal.

The Committee has endeavored to collect information as to the practices followed by different railroads in the matter of number of threads per inch, form or profile of threads and tapers applying to the following screw threaded parts of locomotives:

Staybolts, Crosshead pins, Crank pins, Knuckle joint pins, piston rods, Washout and arch tube plugs.

Information with regard to staybolt threading was obtained from fifteen railroads and one locomotive builder. The replies show that all use twelve threads per inch. Seven use the sharp "V" profile of threads. Six use the U. S. S. profile. One railroad uses the Whitworth profile and the locomotive builder who reported recommends the Whitworth profile, but applies whatever its customers specify.

It appears that eight threads per inch is the accepted practice on those roads reporting for crosshead pins, and knuckle pins though ten threads are used on the latter. And eight threads are used on piston rods re-

TABLE No. 1.

Number or Size	Number of Threads Per Inch	Outside Diameter (Inches)	Pitch Diameter (Inches)	Root Diameter (Inches)	Commercial Tap Drill to Produce Approximately 75% Full Thread	Decimal Equivalent of Tap Drill (Inches)
0	 80	0.060	0.0519	0.0438	$\frac{3}{64}$"	0.0469
1	Fine. . .72	0.073	0.0640	0.0550	No. 53	0.0595
	Coarse. 64	0.073	0.0629	0.0527	No. 53	0.0595
2	Fine. . .64	0.086	0.0759	0.0659	No. 50	0.0700
	Coarse. 56	0.086	0.0744	0.0328	No. 50	0.0700
3	Fine. . .56	0.099	0.0874	0.0758	No. 45	0.0820
	Coarse. 48	0.099	0.0855	0.0719	No. 47	0.0785
4	Fine. . .48	0.112	0.0985	0 0849	No. 42	0.0935
	Coarse. 40	0.112	0.0958	0 0795	No. 43	0.0890
5	Fine. . .44	0.125	0.1102	0.0955	No. 37	0.1040
	Coarse. 40	0.125	0.1088	0 925	No. 38	0.1015
6	Fine. . .40	0.138	0.1218	0.1055	No. 33	0.1130
	Coarse. 36	0.138	0.1200	0.1019	No. 34	0.1110
7	Fine. . .36	0.151	0.1330	0.1149	⅛"	0.1250
	Coarse. 32	0.151	0.1307	0.1104	No. 31	0.1200
8	Fine. . .36	0.164	0.1460	0.1279	No. 29	0.1360
	Coarse. 32	0.164	0.1437	0.1234	No. 29	0.1360
9	Fine. . .32	0.177	0.1567	0.1354	No. 26	0.1470
	Coarse. 30	0.177	0.1553	0.1337	No. 27	0.1440
10	Fine. . .30	0.190	0 1684	0.1467	No. 22	0.1570
	Coarse. 24	0.190	0.1629	0.1359	No. 25	0.1495
12	Fine. . .28	0.216	0.1928	0.1696	No. 14	0.1820
	Coarse. 24	0.216	0.1889	0.1619	No. 16	0.1770
14	Fine. . .24	0.242	0.2149	0.1879	No. 7	0.2010
	Coarse. 20	0.242	0.2095	0.1770	No. 10	0.1935

Recommended Sizes of Machine Screws

gardless of diameter. Twelve threads per inch is the general practice for washout plugs and the taper varies by ¼ in. from ¾ in. to 1½ in. in 12 in.

In view of the divided opinions as regards the form or profile of threads used by the different roads for staybolt work, the Committee does not feel justified in making any definite recommendations at this time, but requests that this matter be carried over until next year in order that more extensive investigation may be made.

The information collected with regard to piston rods, knuckle joint pins, crosshead pins, crank pins and washout plugs, while not representing as many roads as was desired, is considered sufficiently conclusive to justify the Committee in recommending the adoption of the following:

For washout and arch tube plugs—12 threads per inch, U. S. S. profile, taper ¾-in. in 12-in.

For male threaded ends of crosshead pins—8 threads per inch, U. S. S. profile.

For male threaded ends of crank pins—8 threads per inch, U. S. S. profile.

For male threaded ends of knuckle pins—8 threads per inch, U. S. S. profile.

For male threaded ends of piston rods—8 threads per inch, U. S. S. profile.

Briefly summarized, the recommendations of the Committee with reference to screw threads are as follows:

That the investigation of screw threads be continued for another year for the purpose of standardizing the threading of staybolts and other boiler appurtenances. Also for the purpose of revising present standards and recommended practices to clearly specify the form of threads to be used in each case and to reconcile conflicting statements. Further standardization of screw threads used in locomotive construction is desirable and should be undertaken next year.

That all thin castle nuts be provided with 8 threads per inch, U. S. S. profile, regardless of diameter, and that page L-21 of the Manual be revised accordingly.

That certain A. S. M. E. standard sizes and threads, as shown by Table 1, be adopted for machine screws.

That following A. S. M. E. standard heads be adopted for machine screws used in the construction of locomotives and locomotive specialties:

Flat or countersink head, round or button head, flat fillister head—either round or hexagonal.

Definition of an Engine Failure

As the Operating Division has not yet appointed a committee to confer with your committee on this subject a report of progress only is made.

The following memorandum is submitted for discussion and with a view of obtaining the views of the members for the benefit of the committee in its further consideration of the subject:

Locomotive Failures

1. All delays waiting at initial terminal caused by some defective part of locomotive.

2. All delays account of locomotive breaking down, running hot, not steaming well, or having to reduce tonnage, on account of defective locomotive, making a delay at terminal, meeting point, junction connection or delaying other traffic.

The Following Will Not Be Considered as Locomotive Failures

(a) When locomotives lose time and afterwards regain it without delay to connections or other traffic.

(b) When a passenger or scheduled freight train is delayed from other causes, and a defective locomotive makes up more time than it loses on its own account.

(c) Delays to passenger trains when they are less than five minutes at terminals or junction points.

(d) Delays to scheduled freight trains when they are less than twenty minutes late at terminals or junction points.

(e) Delay when a locomotive is given tonnage in excess of rating and stalls on a grade, providing the locomotive is working and steaming well.

(f) Delays on extra freight trains if the run is made in less hours than the number of miles divided by ten.

(g) Locomotive steaming poorly or flues leaking on any run where a locomotive has been delayed (for other cause than defects of locomotive) on side tracks or on road an unreasonable length of time, say fifteen hours or more per 100 miles.

(h) Reasonable delay in cleaning fires and ash pans on road.

(i) Failure of locomotives coming from outside points to shops for repairs, whether running light or hauling train.

(j) Delays due to insufficient time having been allowed in which to make needed repairs or get locomotive ready for time train is ordered to leave, when Operating Department was so advised at time locomotive was ordered.

(k) Broken draft rigging on locomotives and tenders, caused by bursting hose of train breaking in two.

(l) Delays to fast scheduled trains when weather conditions are such that it is impossible to make time; providing locomotive is working and steaming well.

(m) Delays due to locomotive out of fuel or water, caused by being held between fuel or water stations an unreasonable length of time.

Report on Standardization of Water Columns

The Committee, after giving careful consideration to this subject, make the following recommendations for future installations:

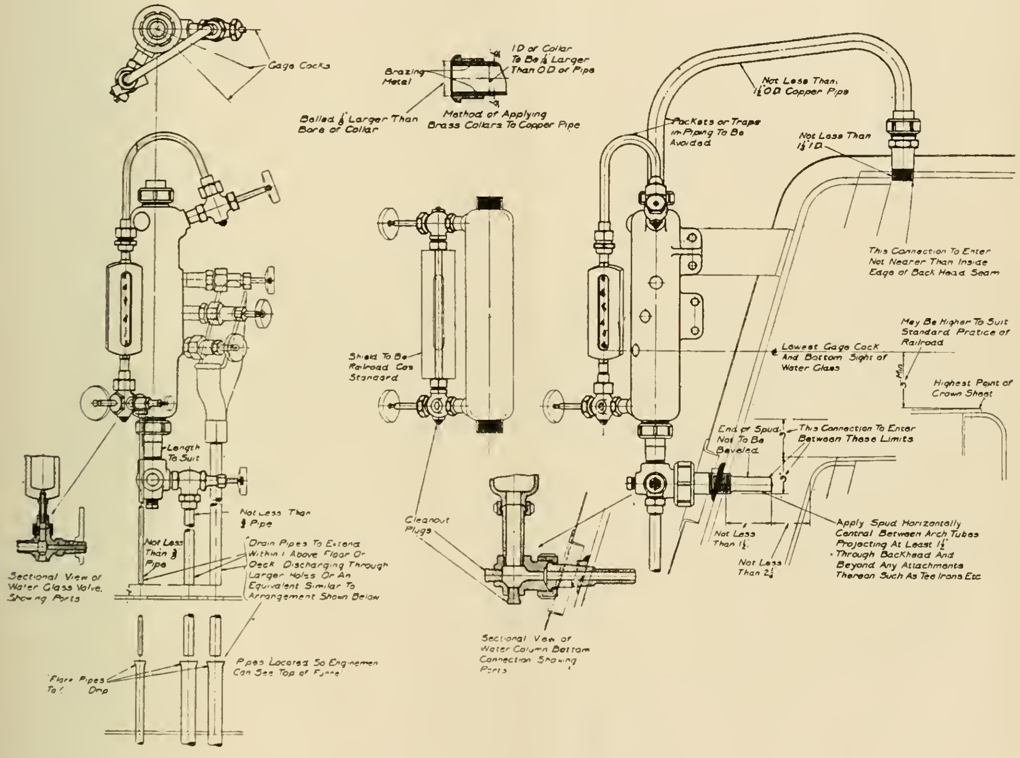
4. Bottom end of column, to provide for vertical range in location, should be supported and connected to boiler with heavy cross connection and spud with clear straightway bored port ¾-in. diameter, with cleaning plugs located opposite horizontal and vertical ports. Spud should be of forged steel or bronze of ample strength to carry the weight of column and attachments.

5. Bottom water column vertical connection to be not less than 1¼-in. inside diameter, preferably larger.

6. Back head of sloping type may be reinforced with open hearth steel bevel washer welded in place to provide horizontal application of bottom spud.

7. Bottom spud must not be located in radius or knuckle of back head flange or immediately above arch tube opening.

8. Inner end of bottom spud must extend not less than 1½-in. through the back head and beyond any



Recommended Practice for Mounting of Standard Water Columns

1. All water columns and water glasses must stand vertically.

2. Water column should be not less than 3 inches inside diameter and of sufficient length to accommodate length of water glass required for the operating conditions and to have a clear opening for top connection of not less than 1½ inches inside diameter and be connected to boiler with not less than 1½ inches outside diameter copper pipe, tapped into boiler on top center or in a location not farther to the side than 9 inches and not nearer than 9 inches to the inside edge of back head seam.

3. Top spud connection standard in boiler to be not less than 1¼-in. inside diameter.

attachments thereon, such as tee, angle iron, boiler braces, etc., to avoid location within water eddy or pocket where water may dam up.

9. Inner end of spud must not extend to or be less than 2¼-in. from firebox door sheet and be located in a vertical range between 3-in. below and 3-in. above the back end of firebox crown sheet.

10. Water column, vertical location, must be at such a height that the lowest gage cock attached therein, and the lowest visible reading of water gage shall be not less than 3-in. above the highest part of the crown sheet and may be located higher, to suit the standard practice of any railroad.

11. Bottom connection of water column must be equipped with not less than ¾-in. drain pipe and valve (preferably one-inch), which can be easily opened and closed by hand, so that the water column and connection may be frequently blown out. The drain pipes should be well braced and extend separately to within one inch of the cab floor or deck, and discharge the waste steam or water through a hole, slightly larger than the diameter of the pipe, or an equivalent arrangement whereby the leakage discharged through these pipes may be observed above the deck.

12. Water columns should be located well toward center of back head of boiler to afford protection and to avoid violent fluctuation of the water while rounding curves. Extension handles to be applied to gage cocks when necessary, so as to bring them within easy reach of the enginemen.

13. Gage cocks must be not less than ¼-in. inside diameter.

14. Top end of water column to be securely braced to back head with a brace sufficiently heavy to carry the weight of column and overcome vibration.

15. Water column to be equipped with one water glass and three gage cocks.

16. Lowest reading of water glass to be on line with center of lowest gage cock.

17. Water glass of Klinger or other Reflex type should have stems not less than ⅝-in. outside diameter and ⅜-in. inside diameter.

18. Tubular glass when used to be ⅝-in. outside diameter.

19. Top and bottom pipe connection to water column and water glass must be applied without gaskets.

20. Water glass steam pipe connection not less than ½-in. outside diameter, preferably ⅝-in. outside diameter.

21. Water glass Klinger or Reflex type top and bottom valve connection bore ⅜-in. diameter. And bottom connection provided with cleaning plug located opposite vertical port and side outlet for the blow off pipe connection.

22. Water glass tubular type top and bottom valve connection bore not less than ¼-in., preferably 5/16-in. And bottom connection provided with cleaning plug located opposite vertical port and side outlet for the blow off pipe connection.

23. Water glass vision not less than 6 inches, preferably 8 inches, depending on operating conditions.

24. Tubular type water glass when used must be equipped with a removable safety shield which will prevent glass from flying in case of breakage.

25. Water glass must be so located and maintained as to be quickly observable by enginemen.

26. Water glass must be equipped with bottom blowout valve and pipe not less than ⅜-in. diameter.

27. Steam pipes to be applied without sharp bends or pockets and provided with ball joint connections and belled at least ⅛-in. in diameter at end in bracing collar.

28. Application is shown by drawing, figure 1.

Removable Hand Rail Columns

Your Committee has been requested to consider a design of locomotive hand rail column that will provide for the ready removal of the hand rail.

The Committee has received prints of a number of designs of such hand rail columns that are in use or contemplated for use on various railroads.

Local conditions, position of hand rails and the uncertainty as to a general demand for such a design suggest the presentation of several designs that have been submitted to the Committee as embodying this special feature of the hand rail column will more properly serve the immediate requirements without making a definite recommendation that any particular design be used.

In this connection the Committee presented nine different designs of removable hand rail columns, identified as Styles No. 1 to No. 9 inclusive. Individual railroads considering the use of a removable hand rail column should be in position to select from these one that will probably meet their requirements.

Locomotive Development

It must be apparent to most railway men that during the past few years there has been a remarkable reawakening of interest in increasing the efficiency of the modern locomotive, with two main objects in view—first: "Fuel Economy," and second, "Increasing the utility of the machine."

While this movement is attributed by some to the demands of the general public, it is our opinion that it has been brought about by the absolute necessity of improving the locomotive to meet changing conditions of traffic and to keep pace with the great improvements in roadway, terminals and general industrial developments. Coincident with this, great interest has been aroused in fuel saving devices due to the great increase in fuel costs, forcing engineers, particularly in foreign countries, to investigate the possibilities of the turbine and internal combustion locomotive. These developments and the building of very heavy electrical locomotives have served as a means of advertising the shortcomings of the steam locomotive, unjustly, thereby preventing to a great extent, a realization of what is being done to increase the efficiency of orthodox types of steam locomotives.

It is mainly for this reason that in the following subdivisions of this paper we briefly summarize progress being made in steam locomotive development along conservative lines:

Part I.—The Steam Locomotive

(A) Major Improvements to Ordinary Designs of Locomotives.

Briefly listed these are:

1. Increased boiler capacity and pressure, and the utilization of this capacity by auxiliaries to increase T. P.
2. Regulation of cut-off by positive or other means.
3. The three-cylinder engine.

A (1) Increased Boiler Capacity.

Comparatively few years ago most locomotives built had boilers which are today termed 85% or 90% using the simple formula:

$$\frac{\text{Boiler H. P.}}{\text{Cylinder H. P.}}$$

the two factors being determined by emperical tables of evaporative values of firebox, flues, etc., based on actual tests.

Today, in the efficient locomotive, all saving in weight due to improvement in materials is being put into boiler, with the following direct result:—Development of maximum power without abnormal rate of fuel consumption. This is only possible by large firebox capacity as evidenced in recent designs of freight locomotives.

It also seems evident that the use of large diameter tubes and type "E" Superheaters throughout the entire gas area, has increased the evaporative value of the boiler due to improved circulation to a greater extent than locomotive builders' tables would indicate.

Combining this with moderately high pressure 225-250 lbs. sq. in., and high superheat 250 deg.-300 degrees—gives us the possibility of a fuel rate of under 4 lbs. of coal per drawbar horse power hour from terminal to terminal.

Basically it is not economic to have boiler power capacity to sustain high speed without being able to utilize a greater amount of it for starting and primary acceleration. This justifies the use of the "Booster" provided there is boiler capacity to develop maximum power up to the limiting speed of the booster—15 m.p.h.

This necessity is brought significantly to our attention by the fact that under what might be termed normal average operating conditions, the average drawbar horse power developed is about 1/3 of that maximum.

To summarize we suggest that the trend of modern steam locomotive design indicates the following for road locomotives:

Boiler capacity—over 100%.

Grate area—1 sq. ft. to 50 sq. ft. heating surface.

Boiler Pressure—225 lbs. to 250 lbs.

Superheat—300 degrees.

Positive indication of steampipe pressure and back pressure.

Long Valve Travel.

A (2) Positive Limited Cut Off.

The positive restriction of cut off such as the 50% cut off developed on the Pennsylvania Railroad, is a distinct advance in fuel economy for locomotives in slow speed freight service on those divisions where the full power of the locomotive is developed for a large proportion of the time.

On account of the many detailed descriptions of this system of steam distribution we merely describe it as the increase of piston thrust by approximately 25%, so as to equalize the limiting of cut off insofar as producing the same average torque and tractive power. This may be obtained primarily by increase of boiler pressure or cylinder diameter or both and calls for no additional parts of any kind, the only changes being in dimensions of combination lever and valve bushings. A small supplementary steam port is provided to supply steam at starting through full stroke.

The proven results of this are:

1. The practical duplication of the uniform torque of the 3-cylinder locomotive.

2. The reduction of peak torque as compared with the ordinary locomotive from approximately 158% normal torque to 131% normal torque, thus permitting a lower factor of adhesion of under 4.0.

3. A possible saving in water of 20% in slow speed service with a correspondingly greater saving in coal, depending on boiler capacity and design.

The only disadvantage which can be named is that due to increase of piston thrust namely, heavier reciprocating parts—a negligible condition in slow speed freight service. We recommend that this should be given the greatest consideration in freight and heavy transfer power where the conditions outlined above prevail. It does not appear to have been definitely determined what exact cut off is the most economical for general freight service or that any economy will be shown by a positive limited cut off as compared with standard arrangement and back pressure indication for high speed freight or passenger service.

A (3) Three Cylinder.

So much descriptive matter has been published in recent years on the three-cylinder locomotive that we do not feel warranted in adding to what has already been done. The principle behind the use of a third cylinder is well described by the following quotation from a test report:

"In a two-cylinder engine, the arrangement of the cranks is such that with 85% cut-off, if the mean tractive effort be 40,000 lbs., at one point in the revolution, the tractive effort will rise to 50,000 lbs., and unless there is sufficient weight on the drivers the engine will slip. In the case of the three-cylinder arrangement with the same cut-off and mean tractive effort, the increase will only be 42,400 lbs., requiring much less adhesive weight to prevent slipping than the corresponding two-cylinder designs.

"It is thus seen that with the three cylinders we may readily get a very high starting torque uniformly applied, thus reducing the stress on the draft gears, and also, that with the train once in motion, it may be hauled with a much shorter cut-off. Roughly, with a train loaded up to the maximum starting capacity in each case, it may be hauled at a 50% cut-off with a tw-cylinder engine, and at two 35% cut-off with a three-cylinder engine, thus promoting the economical use of steam."

The first modern three-cylinder locomotive built in this country was turned out late in 1923 and since that date there have been many others built for all classes of service—most of which are apparently in the experimental stage. The very latest development is the 4-10-2 now being built for the Southern Pacific.

All the criticism directed at the three-cylinder principle has been from the standpoint of maintenance and the Committee does not feel that this class of power has been sufficient service yet to warrant the assumption that it will replace the two-cylinder locomotive.

(B) Changes in Operation Practices and Their Effect on Steam Locomotive Design.

Increased utilization:

This matter is being given most careful study by a special committee of the American Railway Association and it is not intended to enlarge on the subject here other than to point out that the general characteristics covered by Summary of "A" are necessary to provide the possibility of running freight and passenger power on sufficiently long runs to make from 9,000 to 18,000 miles per month.

In addition to the design of the locomotive itself, the tender must be given serious thought and water and coal capacities of a minimum of 15,000 gals., and 20 tons coal respectively should be supplied. The large capacity tank in addition to reducing water stops must have a very important bearing on boiler maintenance as a result of the possibility of choosing suitable boiler water in many places where smaller tanks necessitate the use of bad water.

(C) Special Design of Steam Locomotive.

C (1) Condensing Locomotives.

As a typical example of the condensing locomotive, we submit the following on the Ljungstrom Condensing Turbine Locomotive.

Length overall	72 feet
Total weight	250,000 lbs.
Boiler pressure	300 lbs.
Turbine H.P. (indicated)	2,000
Maximum speed	60 m.p.h.
Maximum speed (Turbine)	12,000 r.p.m.
Tractive power	27,000
Diameter drivers	56 ins. approx.

The Turbine which is of the impulse reaction type is mounted on the front end of what we would call the tender, but what is in reality, the engine end of the unit. Power is transmitted through double reduction gears, and idle gear for reversing, to a cranked jack shaft somewhat similar to the jack shaft on many electric locomotives.

This feature and the method of driving through the pinions has enabled the inventors to reduce from the very high turbine speed of 12,000 r.p.m. to driving wheel speed at 60 m.p.h. of approximately 360 r.p.m.

Other unusual features which space does not permit us to describe in detail are the use of turbines for all auxiliary work except air compressing, induced draft—the heating of air to 300 degrees F. before going to closed pan—radiating type of condenser and heating of feedwater to a temperature of about 295 degrees. The boiler itself is unusual in that tubes are only 10 feet long.

In the design of this locomotive, every effort has been made to approach modern power house practice where we are now developing power for less than 1 lb. per K.W.H.

The results at the time of the investigation indicated that from an engineering standpoint at average capacity, the best vacuum was approximately 26 inches—this may fall rapidly as power developed increases or at low speed, until it is less than half that figure. It may be at once realized that even at its best this cannot approach modern stationary practices of 29 inch vacuum. It is possible that this deficiency may be corrected in subsequent designs by increased radiator efficiency.

Such a locomotive would cost at least double the price of a modern standard type of reciprocating locomotive which, together with the complications of the turbine and drives, does not appear to be suited to our methods of operation and we do not feel that the turbine-condensing locomotive can be justified except where good water and fuel are most difficult to obtain. Developments are still continuing in this line and should be carefully followed.

The best overall thermal efficiency we could expect from such a design would be approximately 14% which would drop rapidly as vacuum decreased. Theoretically this locomotive should operate on approximately one-half the fuel of a similar capacity of reciprocating locomotive, provided that stated vacuum is maintained and that boiler pressure and superheat are at maximum figures shown.

C (2) High Pressure Water Tube Boiler Type.

Experiments are under way on a locomotive of special design on the Delaware & Hudson, description of which has appeared in the technical magazines.

Briefly this engine is a cross compound non-condensing superheated locomotive, with a water tube boiler carrying 350 lbs. steam pressure.

The Committee was unable to obtain any data of interest with regard to the operation of this locomotive.

The McClellon Water Tube Fire Box Locomotive

The McClellon firebox consists essentially of a hollow cast steel mud ring connected to a crown sheet composed of three longitudinal drums by a row of vertical water tubes which form the sides and back head of the firebox. The combustion chamber is formed by a row of curved tubes connected to the crown sheet drums at the top and to a trough leading from the third course of the boiler at the bottom. This trough is connected at the back end and to a riveted and stayed throat sheet leg which also forms the front connection and feeder of the U shaped mud ring.

McClellon water tube fireboxes were placed in service on the New York, New Haven & Hartford Railroad in 1916 on two Mikado type locomotives of 45,000 lbs. tractive effort and are still in service with good operating results and low firebox maintenance cost.

Recently a 250 lb. pressure boiler with McClellon firebox, was applied to a Mountain type locomotive generally similar in details to the U. S. R. A. light Mountain type engine. This engine is now undergoing tests and valuable data will be available in a few months. On account of the heavy maintenance cost of large capacity locomotive fireboxes, we recommend that tests of the water tube firebox be closely followed.

C (3) High Pressure Locomotive.

The use of high pressure steam, 600-1,200 lb. pressure has been experimented with in Europe in stationary practice for over ten years with success. It is pictured by some engineers that this is the only unexplored field of development for the steam locomotive in order to obtain greater efficiency than at present being delivered.

The application of 1,000 lbs. pressure steam in locomotive service must of necessity, introduce serious changes in boiler construction, as the present design is entirely unsuited for such pressures and in addition, must force the use of multistage engines of some sort with re-heating between the stages. Such radical changes and complications cannot be justified in order to secure a greater thermal recovery from a pound of steam until we have exhausted the possibilities of our present locomotive design by securing through the medium of ample boiler and superheater capacity, what we feel is now possible. It must be appreciated by those who advocate the application of the only remaining means of increasing the efficiency of stationary power plants to locomotive service that the locomotive boiler is constantly called on to produce from 500% to 900% over load as compared with stationary boilers producing from 200% to 400% on same evaporative basis. Tests show that at such loads the efficiency of the locomotive boiler may fall below 50% and without doubt, the efficiency of the superheater is also seriously affected as at this rate of evaporation, it is possible that approximately 15% moisture is being carried over in the saturated steam. The only answer to such a condition is increase the efficiency and at the same time, the relative capacity of the boiler and of the superheater. The latest designs of boilers with Class "E" Superheater, increased grate area, and greater relative firebox heating surface will go a long way towards attaining this end.

Part II.—Internal Combustion Locomotive

The steady development which has taken place in the Diesel engine has forced a serious consideration of the application of this or similar types of internal combustion engines to locomotive service.

Briefly stated the characteristics of the heavy oil engine are:

Fuel Consumption Brake Horse Power Hour. .35 to .43 lbs. fuel oil (26 deg. to 28 deg. Baume Sg. 9—.88).

Weight of conservative types. 50 lb.—100 lbs. 1 H.P.

Thermal Efficiency based on B.H.P. 32%—38%.

Up to the present the 4-cycle type have probably given the most reliable and efficient results but the two-cycle type on account of increase in power per unit of weight are now being widely advertised and if all difficulties of scavengering cylinders without too much complication in air compressors are overcome, it will be the logical type to use.

The full Diesel cycle calls for air injection but such progress has been made in direct injection of fuel oil at high pressure it is reasonable to suppose there will be a great future in this type.

The most serious part of the application of Diesel Power to locomotive service is the transmission of the power from the fly-wheel to the rail. It is not intended in this paper to deal with any more than two methods, namely: Electrical and Geared Transmission, as it is felt that there is nothing as yet to justify hydraulic or other complicated methods.

If the application of the gear-driven transmission did not offer special difficulties there would be no need of developing the electric system. Chief of these deficiencies are:

First: The changing of gears to harmonize engine speed and power with locomotive speed and tractive effort.

Secondly: The provision of a system of clutches which will transmit power efficiently and which will absorb abnormal shocks without transmitting them to the engine.

Dealing with the first of these defects, the efficient range of speed of a Diesel Engine is, we will say, from 140 r.p.m. to 450 r.p.m. For example: at 450 r.p.m. power developed is 2,000, consequently at 140 r.p.m. we have available 625. In order to start without undue shock to equipment, the lowest engine speed must be matched by a definite locomotive speed of about 2½ M.P.H. and even then slippage must be provided to prevent shaft trouble. In other words, at actual point of starting the heavily loaded locomotive, there is theoretically no T.P. available, but actually there is the safe amount which should be absorbed by slippage of clutches without reducing engine speed below the ignition point of say, 140 r.p.m. The other gear changes would follow in similar manner to changes in auto or truck service. It is apparent that in going through these changes, there is a loss of power at each change due to reducing the engine speed at the very time when power is most needed for acceleration.

As a protection against damage due to slack running out, buffing shocks, etc., some protection as outlined under second defect must be advised.

To counteract these engineering difficulties the geared transmission offers us the possibility of delivering 95% of B.H.P. to the rail, making an overall possible thermal efficiency of from 30% to 35%.

Up to the present time no really successful geared unit has been developed but serious experiments are now under way at Krupp's, Germany, and important devolepments are expected.

The Oil Electric Locomotive

On account of the difficulties of the geared transmission practically all real development in the use of the internal combustion engines for railway work has been in conjunction with electrical generator and motors. The disadvantages of electrical equipment are:

(1) First cost.

(2) Loss of power through generator and motors resulting in approximately 72% of B.H.P. being delivered to the rail. This reduces the thermal efficiency to rail from 92% to 27%.

It is not intended here to cover the detail description of any particular type of internal combustion locomotive with electric transmission other than to mention very briefly two outstanding experiments, the results of which we will deal with.

First, there has been tested in a preliminary way, the Ingersoll-Rand G. E. Alco machine in switching service in the United States and a Krupp machine on testing plant at Esslingen, Germany.

The general data of the first Rand machine is:

Weight—60 tons.

Engine—60-cylinder, 300 H.P. direct injection 4-cycle engine. Maximum speed, 600 R.P.M., 10-inch bore, 12-inch stroke.

Electrical equipment—600-volt D. C. Generator—200 K.W.

Control—Throttle control—series and parallel controller.

Maximum Tractive Power—At actual time of starting, 36,000 lbs.

This machine has been tested on various railways but was under the rather serious handicap of insufficient power. Even with this disadvantage it has demonstrated in intermittent switching service with a load factor of only 13% that it could make a remarkable saving in fuel, its cost of operation (fuel, lubricating oil, water) being approximately $0.30 per engine hour.

The other extensive experiment is the 1,200 H.P. Diesel Electric Locomotive built in Germany for Russia.

Brief description is as follows:

Weight—250,000 pounds.

Engine—6-cylinder, 4-cycle, 1,200 B.H.P. Diesel Engine, 450 R.P.M., bore, 16 inches, stroke, 16½ inches.

Generator—800-1,200 V., D.C.

Maximum Tractive Power—47,000.

The only reports available on this engine are the testing plant reports from Esslingen which indicate a thermal overall efficiency of between 21% and 28%, the best readings showing a drawbar pull over 33,000 at approximately 10 M.P.H. continuous rating.

To summarize the situation with regard to the Diesel Locomotive.

The present status is entirely experimental insofar as the geared drive is concerned but the Diesel-Electric is rapidly passing out of this stage and is now in the stage of development where operating conditions should be checked up to determine just what economies might be obtained. Of particular interest are those branches of operation such as intermittent switching work, where stand-by losses are enormous.

It is interesting to note that actual operating tests have shown that whereas a steam locomotive under efficient operating condition may have a thermal efficiency of 9%, a switching locomotive on intermittent service in many cases, has an efficiency of less than 1% due to stand-by losses.

It is for such reasons that we particularly direct attention to the possibility of adopting the Diesel Engine to the locomotive, knowing that it is a thoroughly tried and tested piece of equipment.

Probably the easiest mistake to make is to get equipment of insufficient power. For road service it is reasonable to suppose that for main line work powers of less than 2,000 B.H.P. are not of interest to heavy traffic roads—while even for branch line or switching work, at least 600 B.H.P. should be available.

Car Construction

There is a little age-old pleasantry about a woman's letter, in accordance with which it is claimed that all the news is to be found in the postscript.

While it is not quite true that, in the case of the report of the committee on car construction, the appendices contain it all, still the magnitude of these appendices do make the report appear smaller than it really is, whereas the combination of the report itself with its two appendices gives us a volumn of valuable material not often to be found even in the proceedings of the Mechanical Division of the American Railway Association. Briefly stated there are fifteen pages in the report itself, one hundred and four in appendix A, and seventy-seven pages of detail and assembly engravings in appendix B.

Evidently such a mass of material can only be handled in résumé.

The report opens with a list of the items entering into the construction of two freight cars, of the Atchison Topeka & Santa Fe and Union Pacific railways respectively. This gives no description of any of the specialties so listed. The report then goes on to give instructions as to the making of tracings for car work and the conventional symbols to be used. And then partially takes up through the items illustrated in the appendices.

Appendix A deals with the Fundamentals of Design, and starts out with certain requirements that the car must meet. For example, the floor planking must be capable of sustaining a concentrated load of 300 lbs. placed anywhere, so as to provide for trucking stresses. The center sills must be designed to withstand an end load of 250,000 lbs. and so on with the other members of the framing.

In regard to the forces to which a car is subjected the appendix says:

Bulging Force: To calculate the bulging force due to a load of wheat, the Rankine formula, specified in Article 12 of the recommended specifications, was selected as representing good practice. There was no existing data available to obtain directly the bending moments created by a uniformly increasing load on a beam having fixed ends and it was necessary to make a considerable number of tabulations in order to arrive at a correct determination of them. Two different methods were employed namely, the "Influence Line" method, which is very laborious, and a comparatively simple "Formula" method, consisting of a series of formulae developed by your committee.

Centrifugal Force: It was decided to be impracticable to arrive at any satisfactory detailed calculations of centrifugal force. On curves with perfect track and with speed equal to that for which the track is superelevated, there is no centrifugal force exerted by the lading upon the side truss members. When the loaded car is at rest on a curve, there is a force exerted against the side towards the inside of the curve and this probably represents the maximum condition. On a curve having 8 inches of superelevation, the lateral component of the vertical force (w), representing the weight of the lading, is

$$\frac{8w}{56.5}$$

or 14.2 per cent w. If the lading were liquid, 8 inches of superelevation would cause a lateral thrust of 14.2 per cent w. For wheat, having an angle of repost of 25°, this percentage is reduced by the factor

$$\frac{1 - \sin 25^\circ}{1 + \sin 25^\circ}$$

which equals 0.41. Multiplying 14.2 per cent by 0.41 gives a centrifugal action equal to 5.8 per cent of the bulging force. Because of the low value thus obtained, and considering the fact that this maximum condition exists with the car at rest on an extremely superelevated curve, it was decided that centrifugal force could be safely eliminated from the calculations.

Longitudinal Force: An investigation has also been made of the stresses caused by longitudinal shifting of lading, particularly dressed hard wood which probably produces a maximum strain on the ear due to lengthwise shifting of the load, but which would not produce simultaneously as large a bulging pressure on the side of the car as would be caused by a load of grain. It had been observed that car ends having a section modulus of 14.4 had bent in service, the maximum deflection occurring about 36 inches above the floor or about 42 inches above the center line of draft. The longitudinal force required at this point to bend end framing having a total section modulus of 14.4 and assumed to be fixed at top and bottom was found to be approximately 50,000 lbs. With this force so applied reactions at end sills and at end plates were calculated. The portion going to the end sill was assumed to be absorbed entirely by the center sill and was therefore neglected, while the portion going to the end plate, approximately 12,500 lbs., was assumed to be carried to the ends of the side plates and distributed over the entire truss in the form of a static load, being absorbed equally by both center plates. Under this assumption it was found that the resulting stresses in the side truss members were less than those caused by bulging from a load of wheat, and inasmuch as the two sets of stresses would not occur simultaneously, it was decided to neglect the effect of longitudinal shifting of lading upon the side truss members.

Eccentricity: The question of bending moment in side truss columns due to eccentricity of load has received careful consideration. It is known that only loads which are applied between the points of fixity of a fixed end column can cause any bending moment in the unsupported length of the column. Where the ends of columns are firmly fixed with substantially riveted connections, such as at the junction of the side sill with the end of the bolster, it is probable that the bending moment due to eccentric application is taken care of within the connection and in the bolster rather than in the column itself. It was decided that eccentricity of load application could be omitted from stress calculations by inserting a clause in the specifications to the effect that connections of side truss members be detailed so as to eliminate as far as possible, eccentricity effects within the members. Furthermore, it was felt that the large bending moments produced at the ends of the members by assuming fixed end conditions against bulging pressure might tend to offset the bending moments caused at those points by eccentricity of load application.

Oscillation: The effect of oscillation on side truss members was neglected because it was felt that the cross-bearers and bolsters would absorb the greater portion of this force and because it is a force which has not been satisfactorily determined.

Stresses: The unit stresses have been fixed with due regard to the severity of the loads specified. The Rankine column formula, fixed ends, was selected because it is widely used and will undoubtedly take care of the design of columns in car construction with safety. The American Institute of Steel Construction has recently adopted a similar formula for general use, which produces practically the same result as the formula which your committee has recommended, and so it is felt that no great error is introduced by treating compression members in this manner.

In determining the stresses caused by bulging pressure, the weakening effect in the compression members due to a slight deflection caused by the bulging load has been neglected, but this is offset by the clause under Article 12 of the recommended specifications requiring that the length of the members be considered as the distance between the neutral axes of side plate and side sill.

Then follows an elaborate analysis of the stresses to which a car is subjected. A work of such magnitude that it has probably never been equalled in any previous report, and one that it is impossible to adequately review. These calculations which are set forth in complete tabulattions and illustrated by diagrams and stress sheets cover all parts of the car; opening with the side truss members and continuing through the different elements of the construction to the mills.

Appendix B consists entirely of illustrations and, as has been already stated, these illustrations include about every detail entering into the construction of the body and trucks of a 40 and 50 ton wood sheathed American Railway Association box car.

There are 167 of these plates that relate to the body and 46 relating to the truck. The drawings are reproduced with all of the dimensions needed for the production of the several parts. In short it is a complete treatise on the construction of the car to which it is devoted.

Tank Cars

This report deals to a great extent in the details of the tank car, some specific and some general. There is a general description of seven approved designs intended for the transportation of ethyl chloride propane, dinitro-chloro-benzol, sulphur-dioxide, anhydrons ammonia, and molasses, and some narrow gauge cars.

Arrangements have also been completed whereunder service trials of appurtenances and appliances not covered by the specifications may proceed under authority of the Interstate Commerce Commission pursuant to the regulations for the "Transportation of Explosives and Other Dangerous Articles by Freight." This contemplates a limited number of applications of experimental dome covers, outlet valves and other appliances in order that developments in design and construction may be advanced and the perfection of these appliances thereby effected.

There are three appendices dealing specifications, dome covers and safety valves and bottom discharge outlets. Among the interesting items of the specifications is the requirement that the calculated busting pressure of the tank for the IV-A car shall be 400 lbs. per sq. in.

The report of the sub-committee on bottom discharge outlets is contained in appendix C, and contains the detailed specifications of the requirements that this outlet must meet on new cars and replacements after January 1, 1926.

The report closes with a list of forty-five of such outlets that have been submitted. Of these, fourteen have not been approved and four have been abandoned.

Report of Committee on Electric Rolling Stock

When the performance records of steam locomotives are reviewed over a considerable period of years with respect to availability for service, there seems to be indicated a retarding influence contemporary with the development of refinements and the increase in haulage. capacity. These performance records further indicate that, whereas, the simple type of steam locomotive, as used some twenty-five years ago, was available for service approximately seventy-five per cent of the time, the modern steam locomotive seldom produces an average greater than forty-five per cent. While obviously the addition of appurtenances and refinements, all of which improve the operating performance of the unit, will increase the amount of attention necessary to keep the locomotive in running order, yet, the decrease in service rendered cannot all be charged against such refinements. It would seem likely that a large percentage may be due to neglect in providing shop and terminal facilities in keeping with the requirements of the improved and larger power. Or perhaps the high percentage of unserviceable time may be due to a deficient understanding of the possibilities of the modern locomotive with its larger grate area, boiler dimension, general increase in proportions, and therefore greater margin of capacity as compared with designs of former years.

While it may appear inappropriate for your committee to dwell on deficiencies of the steam locomotive, nevertheless it is upon these deficiencies that great stress is placed by the proponents of electrification when the latter is under consideration.

An outstanding advantage of the electric locomotive is the high percentage of serviceability as compared with the steam locomotive. Yet we cannot consistently compare them from this standpoint, unless provision is made for full utilization of the serviceability of which the modern steam locomotive is capable.

The steam locomotive of today is the product of many years of development with the view to simplicity and reliability with the result that the attainment of efficiency has been more or less sacrificed to that policy. Test locomotives have been built and successfully operated, under favorable conditions, whereby, through the utilization of stationary power plant practices, very high efficiencies have been obtained. However, it is quite doubtful that such types will become common, because the maintenance problem presented will greatly offset all other advantages. Generally speaking, the average thermal efficiency obtaining from steam locomotives is little greater than one-half that obtained by the operation of electric locomotives on power generated at first-class stationary plants, properly operated, and the advancement in this respect is more pronounced in the latter than in the former, because of the more favorable conditions. Restrictions as to space is not a factor, skilled operators may be employed with the view to obtaining high thermal and mechanical performance, and refinements in equipment may be instituted since the problem of maintenance does not exist in the same degree as in the case of the locomotive. The possibilities for high thermal efficiencies are very much limited in the case of steam locomotives, the opportunities in this respect are in nowise restrained when applied to stationary power plants of considerable size. However, it should be said in passing this point that the possibilities for sustained service with steam locomotives have not yet been attained and it can be said further that were the inauguration of a group of modern engines within a certain section attended with the same engineering skill and given the same support as is done when electrification is set in operation the results obtained might prove more competitive with the electric power.

The trend of development for stationary power plants in the future undoubtedly will be toward higher initial pressures and temperatures with the object of obtaining higher thermal efficiencies. Such a tendency will have its effect upon electrification projects through a lower unit cost of power. This gain in efficiency will offset a part of the transmission losses or for the same overall efficiency, will permit longer transmission lines and in turn, the concentration of larger quantities of power in the individual plants and of course fewer such plants.

As before mentioned, one of the pronounced advantages from electrification is the peculiar characteristics of this type of equipment which enables it to produce, under favorable surroundings, almost continuous service. Therefore, in laying plans for electrification, full recognition should be given this feature and traffic divisions, for one thing, should be so arranged as to permit long runs, or at least, continuity of runs that will make it possible to gain this advantage. Long mileage of electrified territory is, of course, favorable, but similar results can be accomplished by arranging for prompt return of power at the end of short runs.

The establishment of terminals and shop points has a great deal to do with making electrical operation economical. The terminal should be merely a dispatching point where but little work is done other than the ordinary running terminal inspection and such minor adjustment as may be found necessary. There is small need for machine tool equipment at terminal points, but it is advisable to have a liberal stock of small parts in order to make replacements when needed. Trains should be dispatched promptly with a view of keeping the power on the road with as little lost time at the terminal as possible.

Consideration must be given to the cycle of wear of the various mechanical parts and electrical equipment within each unit of motive power with a view of repairing or renewing such items as become necessary, thus keeping the locomotive in service for the longest period practicable. In this connection it is highly to be recommended that extra parts, even to the extent of providing major units such as complete running gears, traction motors, truck units, etc., be stocked thus reducing the total of complete units to a minimum.

The same may be said of multiple unit cars as far as maintaining complete major repair units is concerned. The situation is different, however, to the extent that ordinarily the equipment reaches a repair terminal on each trip so that the inspection point and repair point in general coincide.

In the routine care of electric locomotives, a difference from steam locomotives is distinctly noticeable. A well designed and operated electric locomotive or multiple unit car, if properly inspected and repaired at periodic intervals, may be run between these intervals without any attention, except such inspection as may be necessary to determine that the car or locomotive is in a safe operating condition. It is recommended that facilities for testing and inspection of electric locomotives and multiple units cars at periodic intervals be developed to a high degree, in order to obtain perfection in the operation, and thus reduce detention and intermediate inspection to a minimum.

In a general way, facilities prepared for steam constitute practically or nearly everything needed for electric—and more. At the general repair shops, the situation is somewhat modified and controlled by the type of equipment. In laying out new shops for either dispatching or general repair work, there may be conditions that might be re-arranged to considerable advantage to improve the order of operations and efficiency.

With the change from steam to electric power, it is in some cases more economical to use multiple unit passenger equipment in place of electric passenger locomotives. When this is the case the passenger car terminal repair shop should receive careful consideration, and will probably require a more radical change than that compared with the steam locomotive dispatching terminal.

Multiple Unit Equipment

There are certain tools necessary for the maintenance of electric multiple unit equipment that must be added to those usually found in steam road passenger car shops.

One of the most important facilities in a well designed back shop, is a large crane equipped with special hooks for lifting car bodies off their trucks and placing them on temporary or shop trucks. While most any type of car or locomotive shop would probably be suitable for multiple unit equipment, the output depends entirely upon efficient handling of the truck repair work. Therefore, traveling cranes should be provided with sufficient capacity to handle complete trucks. Sufficient floor space should be provided between truck repair tracks for piling of repair material for assembly.

Locomotive Dispatching or Running Repair Stations

Treating upon the facilities for the terminal handling of equipment in contra-distinction to repairs in connection with dispatching and running repairs, steam equipment requires essentially provision for coaling, cleaning fires and ash pans, supply water, hot and cold water for boiler washing and filling boilers, steam blower to accelerate fire-building, suitable inspection pits, and a turntable or "Y" to handle engines for return trips. Practically none of these are necessary for the handling of electric power, except inspection pits, sand supply, water for rheostats, where used, and provision for fuel oil and water for passenger locomotives using a steam boiler for train heating purpose. Consequently, in changing facilities for the exclusive handling of electric power, they may be materially less than for steam. For the handling of steam equipment, as also applies to electric power, custom practically establishes one of the terminals reached in the course of the daily run or trip as the home or principal dispatching station. At this station, the major part of the running repairs is made, and in the interest of handling the work to advantage and economically, facilities are provided accordingly and in excess of those provided the other terminals or outlying points. The facilities needed at outlying points for the handling of electric locomotives may be little more than inspection pits, and provision for sand and water supply, depending upon the type of equipment in use.

One idea of the comparison between the inspection and running repairs for steam and that needed for electric locomotives is that the former takes minutes for the inspection and hours to make repairs, while with the electric it takes hours to find the trouble and minutes to make repairs. These figures may be exaggerated, but serve to illustrate the reversal of the conditions.

The actual serviceable time of heavier steam power has been found to be in the neighborhood of 45 per cent as against 85 per cent for electric locomotives. This wide difference in serviceable time is no doubt due in part to the small amount of time required for the work on electric locomotives, in that complete units can be renewed in a comparatively short time. The longer time put on the steam locomotive is accounted for largely by the almost constant attention which must be given to the firebox, flues, stokers, guides, valve gear, reversing mechanism, piston and valve packing and periodic boiler washing and inspection. At outlying points, inspection pits and means for supplying engines with sand and oil are all that is necessary, except where passenger locomotives are handled means should be provided to supply oil and water used in connection with train heating boilers.

For the handling of steam locomotives at the principal dispatching stations a turntable or "Y" is generally necessary to turn the power for the return run, and an engine house of the conventional circular form, with its turntable, well supplies convenience for the routine inspection and repair work. Similarly a turntable has been found valuable in connection with a rectangular engine house for the handling of electric locomotives composed of two or more units, and certain units of other types. By having a turntable or "Y" time can be saved by withdrawing for repairs, but one cab or unit of a locomotive, composed of two or more units, and the substitution of another cab to make up a complete locomotive, thus keeping the maximum number of complete locomotives in service, and at the same time, handle the repairs on the out of order cabs to the best advantage. In making such exchanges, it often times becomes necessary to turn a cab end for end, also to equalize flange wear.

Where electric power has been put in the field replacing steam either partially or completely, the complements of tools needed at the principal dispatching stations will be largely governed by the type of steam and electric locomotives used. Different methods of handling the running repair work at the outlying and principal stations in conjunction with operating conditions, set up problems that must be worked out or adjusted by the railroad to best meet the requirements.

A working pit supplied with a suitable drop pit for wheel and truck work is a convenience that might be considered common to steam as well as electric power, and is as convenient at the general repair shops.

An overhead crane of greater capacity perhaps than used ordinarily at a steam locomotive roundhouse is a convenience and indeed a necessity, in order to lift motors, transformers, rheostats, air compressors, and other heavy parts of the electrical machinery from the frames, either through the hatch in the cab roof or after the cab has been removed.

To handle the work on electric equipment at the dispatching station comparable with the work that would ordinarily be necessary on steam equipment the demands are nevertheless different, and the conditions might be better pictured by considering that in place of the locomotive boiler, steam cylinders, guides, crossheads and valve gear on the steam locomotives, the electric locomotive carries motors, phase converters, control apparatus, rheostats, switches and relays. In place of the steam locomotive cross head, certain types of electric locomotives have the jack shafts, gears or spring quills, and through the latter, the power of the motor operates the locomotive. On an electric locomotive having the same general type of steam locomotive frame and wheel arrangement, the driving boxes, shoes and wedges, and brake rigging are practically the same. The side rods on an electric locomotive are practically the same as on the steam locomotive motives.

For electric locomotives having gear drive and motor armature mounted on the driving wheel axle, the maintenance work on the gear in a general way takes the place of operations corresponding to side rod maintenance. However, the total equipment necessary may be different.

The machine tools required at a steam locomotive dispatching station to maintain such parts would be practically the same for electric.

General Repair Shops

For the major repair work which must be handled at shops corresponding to what is generally understood as back shops or shops where general repairs are made, some inexpensive changes might be made in arrangement of facilities and tools in an existing steam locomotive shop for the same general character of work on electric locomotives, and improve the sequence of operations, inasmuch as they differ somewhat between electric and steam power.

The boiler shop equipment can be eliminated, with the exception of a few tools for the rebuilding and repairing of transformers, rheostats, water and oil tanks and small boilers used on electric locomotives in passenger service.

In most steam locomotive repair shops, overhead cranes have been provided of sufficient capacity to lift a complete locomotive. A crane of sufficient capacity to lift a complete electric locomotive or one cab or unit composing an electric locomotive is desirable, where the design permits, though not always as necessary or as useful as for the handling of a steam locomotive. A crane, however, is quite necessary for the lifting of certain electric parts of electric locomotives, such as motors, transformers, phase converters, rheostats and other heavy parts from the frames either through an opening cut in the roof of the cab, or after the cab has been removed. Under the crane should be provided a well lighted working pit, supplied with a suitable drop pit for driving wheel, removing main motors, truck, brake rigging work and similar work on the running gear for which a pit is a great convenience.

There are many tools in use in the steam locomotive repair shop that might be well utilized in the maintenance of electric equipment, although on account of some of the electrical apparatus being rather special, there may be a demand for a greater number of small tools of special arrangement and design in order to handle small parts of motors, switches, blowers, etc.

As a rule, existing steam locomotive shops, with some slight rearrangement of facilities, are very adaptable for the care of electric locomotives. There are, however, great possibilities for economics in labor and time where new shops are designed for the exclusive care of electric equipment.

Electrification Progress

The activities in electrification during the year 1924 were confined largely to adding rolling stock to existing projects, or the culmination of projects conceived previous to 1924.

Of the outstanding developments that have been brought forth or perfected during the year, those perhaps deserving of special mention are referred to briefly in the following paragraphs:

The development which is perhaps commanding the greatest interest is that wherein the substation equipment is carried as part of the locomotive equipment. Under this heading are locomotives for the Detroit, Toledo and Ironton and the New York, New Haven and Hartford. The D. T. and I. project comprises a 25 cycle, 22,000 volt single phase A. C. distribution with converting equipment on the locomotive to provide 600 volt direct current for the traction motors. The transformers are so arranged that the locomotive can be operated from a 11,000 volt circuit. The New York, New Haven and Hartford locomotives are designed to operate from the 25 cycle, single phase, 11,000 volt A. C. trolley which will be converted on the locomotive to direct current.

A high speed gearless type electric locomotive was placed in service on the Paris-Orleans Railway of France during the year. This is of the 1,500 volt direct current type.

An experimental 3,000 volt D. C. multiple unit car has been built primarily for terminal operation where the main line is 3,000 volt D. C. trolley distribution.

An experimental Oil-Electric locomotive was put into service on the New York Central that tests indicate has great possibilities, particularly for switching and branch line service. However, it is reasonable to assume that, should the application prove successful, its field will not be confined within these limits. A locomotive of the Diesel-Electric type has also been built in Germany for the Russian Government.

Anticipating the need for equipment to compete with the auto bus as well as to reduce operating expense on branch lines, a considerable development has taken place during the past year on Gas-Electric cars and small Gas-Electric locomotives.

It is the opinion of your committee that the work of the Special Committee on Stresses in Railroad Track will have great influence in the future development of Electric Rolling Stock with particular reference to those features which cause track stresses.

Then follows a tabulation of the progress of the past year, which shows that it is world-wide in its scope. It covers a list of eight new designs for the United States, one for Canada and fifty-five for the rest of the world. The rest of the world includes Brazil, Germany, Norway, Sweden, Switzerland, Italy, France, Japan, Java, New Zealand, South Africa and Australia. Electrification developments being reported from these countries.

Report of Committee on Wheels

The new cast iron wheel specifications adopted in 1923 are now in general use and appear to be meeting with approval both from the users and the manufacturers. It has been found in practice that the extra requirements in these specifications, as compared with the old, have not caused the manufacturing difficulties which were anticipated by some makers. There is no questions but what these specifications are proving a help in getting better wheels.

During the year your committee has discussed the question of still further increasing the requirements of the specifications, particularly as regards thermal test, in an effort to get further protection against cracked plate wheels. A considerable number of experiments must be made before any such reccommendation could be presented by the committee, and it is planned to go into this question during the coming year as well as to hold conferences with the manufacturers in regard to the same. Consideration will also be given to the inclusion in the specifications of a prescribed method of chemical analysis.

Developments in Cast Iron Wheel Design

During the year your committee has been watching the developments in the design of cast iron wheels. They have examined some wheels with a lip chill which had been in service for a number of years, in order to get an idea as to the relative merits of these lip chill wheels and the sand rim type. Wheels of both types were broken under the drop and examined to determine the nature of the metal at the rim. The committee came to the conclusion that the lip chill wheel is less liable to chipping of the rim, and that a saving may be accomplished by its use since there are a very large number of wheels removed from service because of chipped rims.

The re-inforcement ring wheels which are in test on one road have not been in service a sufficient length of time to draw any final conclusions. So far as we know there are no more wheels of this type being tested.

The most interesting development in cast iron wheels is the single plate design. Tests which are being made of the 850 lb. single plate wheels in engine tender service have not progressed sufficiently to warrant the committee making any report on same, but it is hoped that during the next year the service of these wheels will demonstrate their merits. Up to the present time we know of no single plate wheels of lesser weight which have been put in service, but we anticipate that some such wheels will be produced and are hopeful that they will prove a help in the reduction of cracked plate wheels, particularly in high speed freight service, such as in refrigerator cars. There has undoubtedly been a radical improvement in the cracked plate wheel situation since the adoption of the heavier arch plate designs. However, cracked plates are still a problem.

Grinding of Cast Iron and Steel Wheels

Your committee made a series of tests on a wheel grinding machine in the shops of one of the member railroads and has the following report to make:

Grinding Slid Flat Rolled Steel Wheels

A pair of slid flat rolled steel wheels with good flanges were selected for test and one wheel of the pair was ground to correct the slid flat spots, the mate wheel later being turned in a wheel turning lathe. On the first wheel, one slid flat spot was 3 in. in length and two additional spots totaled 4 in. in length. The actual grinding time was 13½ minutes. The grinding operation resulted in a loss in wheel diameter of 1/16 in., a reduction in tape size from 262 to 260½ or a loss in service metal of 1/32 in. Mate wheel, with slid flat spot 3¼ in. in length, was placed in a turning lathe for turning in accordance with ordinary practice. The turning operation commenced at 4:44 P. M.; first cut ⅛ in. deep, was so close to the hard layer of metal created by the sliding of the wheel in service that the hardened layer of metal destroyed the cutting edge of the turning tool. It was observed that the hardened layer had a tendency to spring the lathe tool to one side as the wheels revolved in the turning lathe. This tool was changed and a second tool was applied, which was also broken, although the lathe operator was able to complete the rough cut with the second tool. The lathe operator claimed that it would require one-half hour labor to re-grind the two tools tested in the attempt to take the cut in turning the slid flat rolled steel wheels. Turning of the rolled wheel including the rough and finish cut, etc., was completed at 5:26 or 42 minutes from the time the wheel first commenced to turn in the lathe. The tape size after turning was 250, representing a loss in tape size of 12 tapes, equal to a reduction in diameter of ½ in., or a loss in rim thickness of 4/16 in. Actual measurement of rim thickness before and after turning indicated rim thickness before turning 3 1/32 in. and after turning 2 13/16 in. or a loss of 7/32 in. in rim thickness, which checks closely the loss as indicated by the reduction in tape size. It will be noted in connection with this test that the grinding operation resulted in a loss of 1/32 in. service metal, whereas the turning operation under favorable conditions resulted in a loss of 7/32 in. or a difference in favor of grinding of 6/32 in. or 3/16 in. service metal. The wheels in question were 36 in. diameter passenger car wheels rated at $2.03 per 1/16 in. service metal under A. R. A. Rules of Interchange. The saving in service metal for the pair of wheels if ground instead of turned would amount to 3/16 in. service metal per wheel at $2.03 or 6/16 in. for the pair of wheels, which represents a total saving in value of service metal of $12.18. It should be noted further that the labor for the grinding operation was less than one-quarter hour at 63c per hour for grinding as compared to a labor item of three-quarters hour at 75c per hour for turning operation, a saving that will pay a good interest on the cost of the machine.

One of the principal objections which has been raised against the practice of grinding slid flat wheels has been based on the fear that a ground wheel would develop a comby spot at the same location as the original flat spot due to thermal cracks. The best answer to this contention is the experience of those roads which have been following this practice for many years. This shows that these comby spots do not develop. In fact the records show that some wheels have been ground three times. It is important however that the wheels to be ground be carefully selected and only those in good condition except for the flat spot be ground. No shelled, comby or badly tread worn or flange worn wheels should be considered.

It is estimated that a grinding machine, completely installed, will cost $10,000. It is interesting to note that it has been the experience of one road that a large percentage of the cast iron wheels removed on account of slid flat spots were new wheels. This is probably due to the tendency of out of round wheels to be bound in the trucks by the brake shoe application resulting in slid flat spots in cast iron wheels. It follows naturally that when new wheels are placed in the machine and ground after mounting, the number of wheels removed on account of slid flat spots would be reduced to a considerable extent and that further the loss incident to scrapping of new cast iron wheels removed from service on account of slid flat spots is greater than appears to be the case when considering the difference in value between new cast iron wheels and second hand cast iron wheels than scrap cast iron wheels under A. R. A. Rules of Interchange. For instance, the A. R. A. price quoted for 750 lb. cast iron wheels new is $17.40; second hand value $9.55; and scrap $6.30. To reclaim the wheel as second hand rather than scrap results in a saving of $3.25 per wheel or $6.50 per pair, but this does not represent the actual saving for wheels reclaimed after removal from service on account of slid spots on comparatively new wheels. Furthermore, these wheels are better than the average second hand wheel since wheels with badly worn flanges, brake burns, etc., are not ground. To the actual saving of $6.50 in value of the wheels should be added the saving represented by cost of dismounting, remounting, boring, etc.

Cost of Grinding Slid Flat Cast Iron Wheels

Labor ½ hour @ 62c	31c per pair
Interest and depreciation @ 10%, $10,000 first cost (1924 price), 3,000 pairs ground per year	33c per pair
Power 12 K. W. H. @ 1½c	18c per pair
Grinding Wheels @ $55 per pair	37c per pair
150 pairs wheels ground per pair grinding wheels	
	$1.19 per pair
Saving per pair based on second hand values	$ 5.31
Saving per pair based on new values	$21.01

Gage for Re-Mounting Wheels

There has been considerable controversy in regard to the use of the cast iron wheel re-mounting gage. It appears that these gages have been used improperly by some railroads and such use has resulted in the wastage of serviceable material. This gage provides for a satisfactory and definite way of classifying second hand cast iron wheels as between scrap and second hand for billing purposes. It was never intended for steel wheels, though some of the roads have been using it in their shops for this purpose. In order to clarify this matter, the committee recommends that the title for this gage be changed to read: "Limited Gages for A. R. A. Biling Classification of Second Hand Cast Iron Wheels." The Committee does not believe that this gage should be used to determine whether wheels should be re-mounted. There are many miles of service left in wheels which would be condemned by this gage and it therefore appears that there would be a saving in wheels if some lower limits were used to determine the possibility of re-mounting.

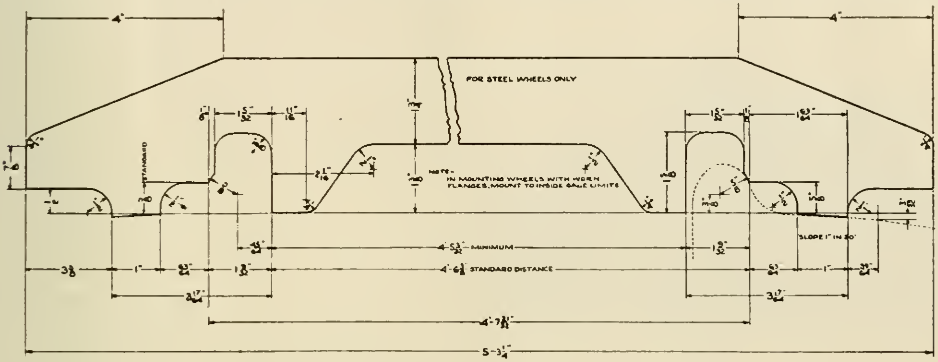


Fig. 1 Flange and Spacer Gage for Re-Mounting Wheels

A combination flange and spacer gage is shown in Figure 1. Some roads are using this type of gage on steel wheels and it has certain advantages which may warrant its consideration by other roads. The commitee is showing this figure for the information of those who are interested.

Pressure Gages for Wheel Presses

At last year's meeting a motion was passed to have the Wheel Committee make a recommendation as to the use of recording pressure gages for mounting wheels. Your committee is very strongly in favor of the use of recording gages as we feel that many wheels are being mounted at improper pressures. The larger railroads are going into the general use of these gages. It does not appear practical to cover this by any rule of interchange. It should be understood that the committee favors only the recording gage which gives the pressure over the entire wheel fit and not the maximum alone. The nature of the fit is just as important as the maximum pressure.

There is also some question as to the correctness of the present standard mounting pressures and some railroads are using a wider range. Your committee is inclined to believe that the range now shown in the Manual is too restricted and that the pressures might very well be increased on the upper side. We have not sufficient data at the present time to warrant our making a definite recommendation as to such a change, but will give the subject further consideration during the coming year.

The committee wishes to call attention to the importance of checking the accuracy of gages used on wheel presses. Ordinarily there are no facilities available for checking these high pressure gages at local shops and as a consequence the gages are seldom checked. This condition leads to bad practice in the mounting of wheels. All wheel press gages should be checked at regular intervals and a record kept of such checks.

Mating of Steel Wheels

Your committee has had requests to lessen the requirements as to the mating of steel wheels. It was claimed that it was not possible to turn steel wheels to the same tape size. However, committee members made tests in their shops and found that with good shop practice wheels can be turned to the same tape size and inasmuch as any greater allowance would tend to produce more sharp plange wheels, your committee feels that the present requirements should stand.

Tread Contour of Steel Wheels

The tests which your committee is running on a number of railroads to gather data as to the relative merits of the various trend tapers are well under way, but the year on the wheels has not been sufficient to warrant making a report at this time. The tests should be completed during the coming year and final report on the subject can then be made at the next convention. In connection with these tests the committee is also including some experiments on the results of running improperly mated wheels.

Questionnaire on Steel Wheel Wear and Contour

In accordance with the Committee's 1924 report, a questionnaire was sent to all railroads to gather information as to their practice regarding tread wear of steel wheels and also as to the desirability of using a standard contour for driving tires and all other wheels, particularly, to determine if a 1 in. flange height for driving tires would be satisfactory. This questionnaire developed the fact that there was a great difference of opinion on these questions. The vote was approximately evenly divided for and against the 1 in. flange on drivers, though the majority stated that it would be advantageous from a shop viewpoint. Your Committee is of the opinion that the 1 in. flange, which incidentally is being used by a number of roads and is used on engine truck wheels, should be standardized. However, in view of the large number of roads opposing such practice, your Committee will not make such recommendation at the present time, but will continue its observation of results secured by those roads who are using this type of flange on driving tires.

The answers to the question regarding tread wear of steel wheels showed clearly the necessity for some definite rule covering this feature. At the present time the removal of steel wheels for tread wear appears to be left entirely to the judgment of the individual. No gage is provided for its measurement and no definite limits have been set. Your committee therefore recommends to the arbitration committee that Rule 76 be changed to require the measurement of tread worn hollow steel wheels, to be based on the height of flange, the limit being 1½ in. and the measurement being taken with a standard steel wheel gage. Your committee in establishing this limit took into consideration the answers to the questionnaire and also contour records which have been maintaned by some of the members. This 1½ in. limit will produce an actual hollow wear of about 3/16 in.

The standard steel wheel gage adopts itself readily to the measurement of flange height.

Steel Wheel Specifications

During the past year your committee has given a large portion of its time to the consideration of wrot steel wheel manufacturing processes. A sub-committee has visited the plants of most of the manufacturers and studied the various processes used. We have also held a conference with the representatives of the different manufacturers and upon our request they have formed a technical committee to work with your committee in the development of the wrot steel wheel. The service to which steel wheels are being put is becoming more and more exacting, particularly in locomotive tenders, and improved processes are necessary to fully meet these requirements.

Limits of Wear on Rolled Steel Wheels

At the last meeting the committee recommendation to reduce the limit of wear for rolled steel wheels in switch engine tender service was approved. The matter was referred to Mr. Pack of the Interstate Commerce Commission and he has issued a ruling permitting this lower wear limit under the I. C. C. Inspection Rules. The railroads are therefore able to take advantage of this further saving of wheels.

The Committee was requested to consider reducing the limit of wear on all tender wheels and also on all passenger wheels. Though all the reports indicate that no trouble is being experienced with the lower wear limit in freight cars, your Committee does not feel that sufficient experience has been had with these lower limits to warrant their making such recommendation at this time. We wish to protect passenger car and engine service in every possible way and it should be remembered that passenger car wheels worn to 1 in. need not be thrown away as they can be transferred to freight service.

The rolled steel wheel is not permitted to be worn under passenger cars or under tenders of road engines to less than 1 in. rim thickness. It is probable that this amount of dead or unused metal is more than safety requires. This limit was established in the days when steel wheels were mostly steel-tired with an independent center. This type of wheel did not have the strength in the rim which is possessed by the single plate rolled steel wheel of today. It seems reasonable that the rim of the more modern rolled steel wheel can be worn to a thinner section than can the rim of the steel tired or assembled wheel. If this is correct, the present standard of 1 in. thickness at which rolled steel wheels are condemned from passenger service and road engine tenders, wastes some metal in each wheel.

Brakes and Brake Equipment

The committee opens its report with a statement as to the desirability of an adequate brake beam safety support, and says that there is nothing of the kind in use that is satisfactory but that it is continuing its efforts to develop something that is.

It declines to accede to a request for a revision of the price for brake cylinder packing. It has conducted tests which are not completed in order to determine if possible a standard capacity of retaining valve for freight cars.

It also declines to place repaired brake beams in the same classification as new beams, because the price is already sufficient to reimburse the railroads for the repairs, and because of the probability of their needing repairs again much sooner than new beams.

The subjects of strengthening brake hangers and making changes, in the graduating springs of freight triple valves is also under advisement. Attention is called to the changes that have been made in the A. R. A. brake beam gauge, and to the position of the beam, and it is recommended that the gauge drawing shown in the manual be changed to conform to meet these conditions. The same holds for the brake head gauge drawing.

Attention has been directed to the practice of stretching springs in the Spring Type Retaining Valve, presumably for the purpose of overcoming leakage of valve seats. This trouble was more prolific when the spring type retainer first came into general use than is the case at the present time. The Committee strongly recommends that each railroad call attention of their repair men to the practice of stretching these springs and request that such practice be discontinued. Stretching of the springs increases the brake cylinder pressure retained, reduces the flexibility of control and may contribute to wheel and brake shoe troubles.

Your Committee recommends for letter ballot to the members this year the following:

The Committee's attention has been called to cases where there is an appreciable difference in the actual and nominal diameter of brake cylinders which influences the life and efficiency of brake cylinder packing on account of cylinders being considerably larger than the nominal diameter. Your Committee would, therefore, recommend for adoption as recommended practice, that the actual diameter of brake cylinders for freight cars should not exceed the nominal diameter by more than 1/16 inch.

Advancing to standard the present recommended practice brake beam having central head hanging only.

The Aroostook Valley New Electric Freight Locomotive

By R. E. Hodgkins, Railway Department, Westinghouse Electric & Manufacturing Company

The Aroostook Valley Railroad, located in the northeastern part of Aroostook County, Maine, has headquarters at Presque Isle. The line extends from Washburn Junction, where it makes connection with the Canadian Pacific Railroad, to Sweden, Maine. A branch line runs from Carson to Caribou. This railroad started operation in 1910 with a 1,200-volt overhead system. The total electrified trackage is about 27 miles. The road handles a considerable amount of the freight traffic in and out of the Aroostook Valley territory which is famous for its potato production.

The principal motive power equipment consists of one 40-ton locomotive, one heavy double-truck freight car, three double-truck interurban passenger cars and one new 60-ton Class D Baldwin-Westinghouse freight haulage locomotive. During the year 1923-24, this road handled 3,746 cars of potatoes, averaging 675 bushels per car, which, at 20 lbs. per bushel, makes the average car weight 20¼ tons. The total car shipment of potatoes out of Aroostook County was 32,637.

The weather conditions during the larger part of the year are very severe. There is considerable snow and cold weather, and temperatures ranging between 25 and 35 degrees below zero are not exceptional. In spite of this weather handicap, the railroad maintains excellent service in handling its freight traffic.

The 60-Ton Class D Baldwin-Westinghouse locomotive which was recently placed in service is the latest addition to the motive power equipment. It was designed particularly for this installation.

The mechanical parts are standard for Baldwin-Westinghouse locomotives having a central compartment housing the electrical equipment, except the compressors and blowers which are mounted near the sloping hoods at each end of the cab.

On account of the severe snows encountered on this road, the headlights are mounted on swivel pivots directly under the roof overhung at each end of the cab. This protects the headlights from the weather and also provides the maximum availability under all conditions of weather.

The air brake equipment is of the standard 14-EL type particularly adapted for operating in multiple with standard steam railway equipment. The compressors are of the D-4-P 50-ft. type. The motors are wound for 1,200 volts per commutator. The blower motor is a special 1,200-volt motor with ball bearings and this is used to ventilate the main propulsion motors, one of which is mounted on each axle. The air is obtained from the inside of one of the hoods, which contain louvres. In this way the maximum protection from weather, snow or dirt, is afforded in driving motors. The air is conducted through an air duct formed by closing the space between the two center channels with a piece of iron sheeting and led directly to each motor through a flexible air connection.

Electric Freight Locomotive for the Aroostook Valley Railroad

This blower equipment supplies each motor with 800 cu. ft. of air per minute. This greatly increases the continuous capacity of the motors and which is very necessary when the locomotive is to do a large amount of switching service.

The electrical equipment is mounted on angle iron framework inside the center portion of the cab and because of operation on a 1,200-volt system, double insulation is afforded for live parts. A unique feature in connection with this locomotive is that all auxiliary circuits are fused to a common bus bar. Fuses of the expulsion type are used. A separate auxiliary control cutout switch is mounted adjacent to the auxiliary fuses so that by opening this switch the auxiliary fuse bus bar is dead and fuses may be replaced without danger to the operator.

The unit type of switch, mounted between angle iron framework, is used for control of the main motors. The grids are mounted close to the ceiling directly under ventilators with the other main apparatus below and adjacent thereto. This arrangement, together with solid covers which enclose the greater portion of the control cabinet, allows the head of the grids to set up drafts which ventilate the control compartment.

The locomotive is arranged for double-end operation. The driver's seat is located conveniently to a side window. The operator has a clear vision, as there are two windows and a door across the front of the locomotive. The instrument board is of special design so that the top does not come above the lower frame of the window and the ammeter and air gauges are illuminated by a special arrangement of lamps. The whole electrical equipment is arranged for maximum accessibility and ease of inspection and maintenance.

With this locomotive added to its present equipment, the Aroostook Valley line can handle their freight traffic more expeditiously and efficiently.

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The Superheater and the Throttle

It may not be strictly true that the designer of the modern locomotive has cut himself entirely free from precedent, but it is true that he no longer does things simply because they have been done in the past. If the methods of his predecessors involve inconvenience or expense away they go, and the location of the throttle is a case in point. In the old locomotives carrying a low pressure, with which the unbalanced sliding throttle valve was quite feasible, it was very convenient to have it located in the dome. There, by simply removing the dome cap it was accessible for regrinding and repairs. But with the growth of the machine, the dwarfing of the dome and the necessity of using a balanced throttle, this location did not have the advantages possessed by the earlier designs. The space in the boiler occupied by the drypipe became valuable as a steam space, and it was found that by placing the throttle nearer the cylinders, as in stationary practice, made a better handling of the engine possible. This involves placing the throttle between the superheater and the cylinders instead of between the boiler and the superheater as in the earlier practice.

That there is a tendency to follow this new practice is shown by a number of locomotives of recent design, as, for example, in the high pressure compound locomotive for the Delaware & Hudson and the latest design of the Lima Locomotive Works, illustrated in Railway and Locomotive Engineering for January and May 1925.

This arrangement seems to possess many advantages over the old provided it is properly used.

Parasites are accumulating upon the locomotive and each of these demands a steam supply that can best be provided by the use of superheated steam. There is now the booster, the air pump, the feed water pump, the lighting turbine, the blower and the whistle, all of which should use superheated steam.

In fact, with the throttle between the superheater and the cylinders it is almost imperative that superheated steam should be supplied to these auxiliary parasites, in order that there may be a continuous flow of steam through the superheater units. Standing as they do constantly under full boiler pressure, it is essential that they should be protected against overheating, lest the fittings be stretched or burst, and this can only be effected by a constant circulation. Besides this, these parasites are heavy consumers per horsepower or power developed and there is a possibility of a considerable saving in the weight of steam consumed if they are taken in the aggregate. Because it has been found that their total steam consumption ranges from 10 to 14 per cent of the total production of the boiler. And the saving to be effected by the substitution of superheated for saturated steam in from 10 to 14 per cent of an engine's production is no insignificant item.

The air pump is a notably inefficient machine and the rate of steam consumption of the lighting turbine per horsepower would be damning in large units.

Even the work of the whistle is improved by the use of superheated steam, in that not only is its tone improved but there is a shorter time interval between the opening of the valve and the production of the full tone than when saturated steam is used. This is especially noticeable in marine work.

The blower, too, should take superheated steam because of its extensive use when the throttle is closed to keep the cab cleared of smoke. This will provide the circulation needed to protect the units, and at the same time cut down the consumption of steam by the blower itself.

Then, even though this circulation were not required for the protection of the units, it is reasonable to use a money-saving device like the superheater as much as possible. It is there and the more extensively it is used the better for it and the greater the savings that it will effect. So why not use its products for everything?

When reviewed in its entirety there seems to be very many good reasons for placing the throttle between the superheater and the cylinders and very few for retaining it in its old position in the dome, and putting the superheater out of commission whenever the engine is not using steam and also so making it impossible to take advantage of its steam saving possibilities in the auxiliary parasites.

A Wheel Manual

For a number of years, and that was years ago, the American Railway Engineering Association, seemed, to the casual observer, to be devoting the greater portion of its time, in conventions assembled, to the discussion of the provisions of a manual that it was preparing, and which also appeared to that same casual observer to be intended to form a compendium of all human knowledge and practice in the matter of railway track and buildings.

Since that time many other associations have followed and the manual of a technical society is now a matter of course.

The latest addition to the list is that of the wheel committee of the Mechanical Division of the American Railway Association.

That it is a valuable addition to wheel literature goes without saying, when the personel of the wheel committee is considered. That it is interesting will follow from the reading thereof, just as the good of the pudding is best determined by the eating.

It is to be regretted that a complete reproduction of this manual in these columns is impossible. It contains so much that so few men know, that its contents should be sown broadcast in the minds of all who have to do with wheels under cars, and that includes not only every railroad man, but a great portion of the public if riding on a car can be interpreted as "having to do with wheels."

It may not be essential that all having to do with wheels should know how they are made. But, just the same, they ought to be interested in the subject, and if they are their interest and curiosity can be satisfied if they will but turn to the pages of this manual.

First it takes up the manufacture of wrought steel wheels, and describes the progress of the steel from its being poured into the ingot mould, through the pressing and rolling to the finished product, with very clear illustrations as to the methods pursued.

Then, after it has described the process of manufacture it deals with the inspection, and defects; and it is here that the illustrations come to the front in twenty excellent reproductions of the various types of defects and failures that appear in wrought or rolled steel wheels.

The chapter on cast steel wheels is comparatively short, the principal elements of which are the chemical analysis, physical properties and the heat treatment to which they are subjected.

Then comes our old friend, the great standby of American railroads, the cast iron wheel. We reach the description of the methods of its manufacture as a woman reads the description of her party dress in society columns of her morning paper. Not that she doesn't know about the dress, but because she is interested in the subject.

We have all seen the engraving of the section of a wheel moulded many times, but it is always interesting. And it is interesting, too, to see how carefully that great piece of metal running less than three to the ton, is cuddled and cared for and coaxed into a condition of maximum strength and minimum internal stress. It is a great game, that taming of the disrupting forces of cooling cast metal, and well worth knowing about.

Of course, the cast iron wheel has its illnesses and if we don't know of them it is because we have been deaf to the discussions on the subject during the past forty years or more. So the twenty odd illustrations that are presented come as familiar acquaintances as measles and croup are familiar to the mothers of large and otherwise healthy families.

And as the mothers ought to read Dr. Holt as to the care of their babies so the shop men should read the manual as to the boring and pressing and gauging of wheels, for it seems to be all there.

Referring back to the body of this report, there is one item of considerable significance, which might lead one to the use of the advice to refrain from crying until you are hurt.

It was not so very many years ago that there was a howl of anguish and protest over the suggestion that a chemical requirement could be profitably added to cast iron wheel specifications.

It seems to be a characteristic of railroad men to howl when anything new or any change of practice is suggested. And then, having howled, to proceed not only to make the best of the change but to make the change of the best.

And now, probably referring to these changes, the committee says: "the extra requirements * * * have not caused the manufacturing difficulties which were anticipated * * * and your committee has discussed the question of still further increasing the requirements of the specifications, particularly as regards thermal test."

Certainly wheel manufacturers and the railroads are actively engaged in the intensive cultivation of this necessary item of car construction.

Railways in the Northwest

Elsewhere in this issue will be found an article on the status of certain railways in the northwest, which embodies in tabulated form much statistical data with respect to:

(a) Finance: Capitalization—subdivided as to stocks and bonds, also amount per mile.

(b) Traffic: Tonnage handled—subdivided as to commodities, and amount originating on line.

(c) Operating Statistics: including various items bearing on volume of business, or degree of economy from operation.

A second tabulation shows that the volume of freight business handled in car loads and total tons carried subdivided as between that originated by the carrier and that secured from other lines, with the average amount received per ton of freight handled, the average length of haul in miles, and the average rate per ton mile.

The purpose of this and preceding articles in Railway and Locomotive Engineering on this subject, is to show that the *rate structure* had absolutely nothing to do with the agricultural depression in the northwest, and the real cause of such things as the St. Paul receivership was due to:

(a) Lack of sufficient volume of high grade traffic. And

(b) Too great a bonded debt, rather than to the rate structure itself.

We think a careful study of the article and the two tabulations alone referred to will serve to confirm this position, thus making it clear that the financial structure of the property must be so reframed as to provide ample working capital to meet present and future obligations, so that the company can easily within its income meet all obligations, and eventually pay a fair margin of profit to the owners. To do this the holders of bonds and stock will of necessity be required to participate in providing the necessary funds.

The railways of the northwest have been pretty hard hit as the result of the agricultural depression in that section, and although requests for increased rates are pending before the Interstate Commerce Commission, yet it is somewhat problematic as to just what they will finally do in the matter, particularly so in view of the fact that the worst of this depression now seems to be behind us, and that to authorize a general increase in that section or region would no doubt meet with a storm of protest particularly from shippers along lines that are now fairly prosperous on present rates, while if calculated to aid any particular line, a similar storm of protest would come from shippers and the more prosperous lines whose excess pooled earnings were to be so distributed.

A study of table No. 2 will materially aid in making this feature clearer than it may seem at first blush to those, if any there be, who may think the Commission can give immediate and permanent relief to the St. Paul's financial troubles by simply authorizing a horizontal increase in all rates, when as a matter of fact such is not the case.

The Chicago & Northwestern, it will be noted, has a low average revenue per ton and low average length of haul, but rather high average rate per ton mile.

The low revenue per ton and average length of haul is no doubt due to the fact that they handle a great deal of iron ore and coal which only moves a short distance and yields the lowest income, while the heavy volume of high grade tonnage delivered to the Union Pacific at Omaha and to the Northern Pacific & Great Northern at St. Paul for the Pacific coast or for other western points. As a result of this reciprocal arrangement the Chicago & Northwestern does a big business on the Pacific coast although they haven't a foot of track within 1770 miles of the coast, on this through line. The Union Pacific which starts from Omaha 488 miles west of Chicago, and ends at Ogden, 990 miles west of Omaha and 783 miles east of San Francisco, also does a big business both out of Chicago and San Francisco, through the medium of Chicago & Northwestern on the east, and the Central Pacific on the west.

It is interesting to note that although the Northwestern handled 52,158,316 tons of freight that only 33,327,579 tons of about 64% of it originated on its own lines, and that the Union Pacific handling 18,169,301 tons only originated 10,191,456 tons or about 56%, although each of these lines received an average revenue per ton mile of $.01222 or about $.00149 more than the St. Paul.

The Chicago Great Western with only 1496 miles and average rate per ton mile $.00978 not only secures about 65% of its business from off its own line, but has an average length of haul of 292.9 miles, or 60 miles above the St. Paul.

The results obtained by the four lines mentioned, and to which may be added the Burlington, show the possibilities of a good traffic or selling organization in securing high grade, long haul tonnage.

The Chicago & Northwestern, Union Pacific and Central Pacific constitute one transcontinental line between Chicago and the Pacific coast, of 2261 miles, just as the St. Paul does over its own rails direct from Chicago, and while the three former lines were hard hit by the agricultural depression, particularly the Northwestern, yet they met all fixed charges and have regularly paid dividends on both preferred and common shares of stock.

Though joint ownership of the Burlington, the Northern Pacific, and Great Northern reach Chicago and other important traffic centres served by the Northwestern, Union Pacific combination, and while these three lines were similarly effected by the recent agricultural depression, introduction of motor trucks, competition of Panama Canal, etc., yet these three lines have also met all fixed charges and regularly paid dividends on stock, although two of them have a lower average rate per ton mile than the St. Paul. The Great Northern being $.01070, while the Burlington is only $.00996.

The fact that the Northwestern and Burlington have not only met all fixed charges and regularly paid dividends on their stock during the recent depression in the northwest was due to the fact that their financial structure was such that they could meet these adverse conditions, and remain solvent under the same rate structure of other lines in that territory.

The capitalization of these two lines is comparatively low, the total for one being $50,358 per mile and the other only $36,672, while the bonded debt of the Northwestern is only $30,558 per mile and the Burlington only $18,484.

From the foregoing it would appear that the primary cause of the St. Paul's financial troubles does not reside in the rate structure—as to the remedy, that is a different story.

The St. Paul was for years one of the best railways in the northwest and its gilt edged securities were much sought after by careful conservative investors.

The common and preferred shares were on a 7% basis until 1911 and sold at $133 and $155 in that year, while in 1906 the common sold at $199 and the preferred $218 per share, but in 1918 both dividends were passed, and the shares gradually dropped in 1925 to $3.25 for the common and $7.00 for the preferred.

Many students of transportation conditions in the west, including bankers and railroad men, at the time the St. Paul decided to build a new expensive line, crossing two ranges of mountains, from the Missouri river to Puget Sound, when the lines already there were at times having a hard time to make ends meet, thought there was no need for an additional transcontinental line, and that there was *not* and would not be in any reasonable time sufficient business to support it, and from a financial standpoint it was entirely too risky. In fact it is related on good authority that the head of the Northwestern Railroad, who was then and is now one of the ablest railway executives in this country, was strongly urged by some of his directors and other colleagues to build to the coast, with the advice that if he did not the St. Paul would, and thus have a decided advantage on coast business. The advice and appeals were respectively listened to, and his reply was as follows:

"Gentlemen, the lines to the coast now find it hard to make ends meet in lean years. Most of them have been through bankruptcy and we are not now sure some may not again be forced there. We now have a good Pacific coast connection which we are in no danger of losing, and that without a dollar invested in it. To build an expensive line across two mountain ranges thus saddling on ourselves a huge debt with increased fixed charges, and antagonizing the present coast lines by fighting for a division of their business, with little assurance of success, is entirely too risky a proposition, and I will not jeopardize our financial status by going into it. We will stay where we are and continue to not only do business on the coast through interchange connections, but pay our shareholders a return on their investment."

Time has shown this gentleman's appraisement of the situation to have been absolutely correct, but this is now water over the wheel. The roads of the northwest have suffered more than in most other sections both from *depression* in business, and *oppression* of the insidious propaganda so pronounced in that section. Their rates have not been and are not now as high as they should be when considered with respect to cost of material labor, taxes, etc., and there should either be an increase in the one or a reduction in the other. Relief through this channel, however, will *not* provide increased tonnage for any line or reduce fixed charges on bonded debt, or provide new capital for rehabilitation purposes, the first of which the St. Paul needs and the two latter seem absolutely essential to its future existence. It would seem to be incumbent on the owners of the securities to join in such financial plan as will make it possible for the St. Paul to *live within its means* under the same rate structure of other lines in that section of the country, and thereby insure uniformity of rates and fair treatment to all patrons for the same or similar service in the territory served.

No one knows when there may be a return visitation of agricultural depression in the northwest, fresh outbreaks of anti-railway propaganda, or just how fast the country through which the St. Paul runs may develop into a traffic producing territory, but regardless of these factors and the question of increased rates, it would seem that no financial plan or structure should be adopted that is not capable of surviving just such adverse conditions as have prevailed in the past, and may have to be again faced in the future.

Some Plain Facts With Respect to Chicago, Milwaukee & St. Paul Ry. Co.

By W. E. SYMONS

Holders of securities of the St. Paul Railway have been advised to *not* deposit same and thereby participate in the proposed plan of reorganization, those who oppose the plan setting forth as a basis of their opposition to the plan, that:

1. The poor earnings of the St. Paul *are due* to the *rate structure*.
2. That the St. Paul's troubles *are not* due to its financial structure, and
3. That no reorganization should be consummated until the pending rate applications have been decided and every effort to obtain fair rates has been made.

Figures are presented to prove that the difficulties of the St. Paul are *not due* to its financial structure, but to *inadequate rates*.

The figures on which the foregoing is based are of opposition to the reorganization committee's plans will only tend to prolong and aggravate the case.

Rate Structures or Inadequate Rates

The amount that may be charged by carriers for the transportation of freight and passengers between certain specified points is determined by the Interstate Commerce Commission, and may be considered as the rate structure under which commodity rates are established. These rates or unit prices multiplied by the quantity or volume of the different commodities handled and the distance hauled govern the income of each carrier, and while railways in the northwest in particular have suffered from lack of sufficient income to properly support all lines, yet the trouble is more due to loss of volume of business than chargeable to inadequacy of rates, while the St. Paul being

SELECTED ITEMS FROM GOVERNMENT REPORTS FOR THE YEAR 1923. W. E. SYMONS June 1925.

	ITEMS	NORTHERN PACIFIC	GREAT NORTHERN	SOUTHERN PACIFIC	CHICAGO and NORTHWESTERN	CHICAGO GREAT WESTERN	ST. PAUL	TOTALS AND AVERAGES	PER CENT of ST. PAUL ABOVE or BELOW	NO.
FINANCIAL	Mileage (operated)	6,679	8,251	7,425	8,462	1,496	10,987	43,300		1
	Capital Stock (common)	$248,000,000	$249,477,150	$372,380,905	$145,152,500	$45,210,513	$117,406,000	$1,047,537,763		2
	Capital Stock (preferred)				$22,395,000	$46,907,000	$115,845,800	$284,691,300		3
	Average Per Mile	$37,101	$30,236	$50,152	$19,800	$61,575	$21,229	$35,015	36.4	4
	Bonds	$318,649,000	$318,077,429	$316,673,342	$258,586,900	40,503,698	$440,807,116	$1,639,120,099		6
	Average Per Mile	$47,709	$38,550	$42,649	$30,558	$27,141	$40,120	$37,787	5,87	6
	Total Capitalization	$566,649,000	$567,554,579	$689,054,247	$426,134,400	$132,621,713	$674,058,915	$2,954,349,664		7
	Average Per Mile	$84,810	$68,786	$92,801	$50,358	$88,669	$61,349	$72,802	15.7%	8
TRAFFIC	Net Ton Miles per Mile per Day	3,449	3,320	4,234	3,629	3,886	3,475	4,069	14.1	9
	Gross Ton Miles per Mile per Day	7,788	7,305	11,429	8,484	10,216	7,768	8,549	29.1	10
	Train Load--Tons Rev. & Non-Rev.	734	814	661	552	618	645	670.6		11
	Revenue per Freight Train Mile	$7.05	$7.62	$8.39	$5.58	$5.75	$5.91	$6.66	11.2	12
	Expense per Freight Train Mile	$1.65	$1.93	$1.99	$1.42	$1.61	$1.44	$1.58		13
	Products of Agriculture	19.8	17.4	15.3	14.5	25.1	16.0			14
	Animals and Products	1.5	1.4	2.0	4.9	9.0	5.1	4.83		15
	Products of Mines	[illegible]	61.1	28.3	45.5	25.3	36.3	33.33		16
	Products of Forests	[illegible]	11.3	28.3	11.6	8.1	21.3	20.06		17
	Manufactures and Miscellaneous	11.2	7.1	23.1	19.7	28.7	17.8			18
	All L.C.L. Freight	2.5	1.7	3.0	3.8	3.8	3.5	3.10		19
	Per Cent Originating on Line	82.5	90.7	73.3	64.6	35.1	73.5	66.3		20
STATISTICS	Aver. No. Freight Cars per Train	42.3	44.5	43.5	34.6	41.5	38.8	41.16		21
	Average tons per Car	26.	[illegible]	22.9	24.8	21.6	25.6	24.7		22
	Average Length of Haul	284	240.6	259.1	158.9	292.9	232.3	244.6	6%	23
	Revenue per Ton of Freight	$3.21	$2.57	$3.84	$1.94	$2.86	$2.49	$3.04	14%	24
	Revenue per Ton Mile of Freight	$.01132	$.01070	$.01483	$.01223	$.00978	$.01073	$.01160	.00087	25
	Revenue per Pass. Train Mile	[illegible]	$1.91	$2.60	$2.19	$1.86	$1.99	$2.04		26
	Revenue per Pass Mile	$.03223	$.03349	$.03136	$.03446	$.03374	$.03335	$.03268	.00067	27
	Average Pass. per Train	[illegible]	[illegible]	70.9	59.4	41.5	44.5	48.36		28
	Total Revenue per Mile	$15,298	$14,547	$27,900	$18,957	$17,194	$15,406	$18,216	15.4%	29
	Operating Ratio	[illegible]	72.3	67.4	82.6	83.3	79.6	77.65%		30
	Dividends on Stock	5%	5%	6%	4 & 7%	none	none			31
	Freight Car Miles per Day	34.7	29.1	[illegible]	27.8	41.7	31.6	32.1		32
	Cost Trn. & Eng. Serv. per 1,000 Ton Miles	$1.011	$1.121	$1.198	$1.107	$1.080	$1.008	$1.089	0.089	33 34
	Cost of Coal per Ton	$4.52	$4.96	$5.39	$2.96	$3.87	$2.90	$4.09	29.3%	35
	Lbs. Coal per 1,000 Grs. Ton Miles	133	150	147	167	169	160	164.3		

Tabulated Comparison of Capitalization, Traffic Commodities, Operating Statistics, Etc., of Five Western Railroads and the Chicago, Milwaukee & St. Paul Railway

course quite interesting, the most interesting feature, however, being the fact that they are *not* applicable, and therefore will not bear analysis.

Of the four (4) lines used as a comparison with the St. Paul, by one of the opponents to the plan, two are north and south lines on the Atlantic Seaboard between the Potomac River on the north, and Mexican Gulf points on the south, while the other two radiate the southwestern territory from St. Louis, Mo.

None of these four lines are transcontinental as is the St. Paul, and their average rate per ton or ton mile is not comparable with lines handling traffic between Chicago and Pacific Coast points, and the fact that the average rate per ton mile is higher on these four lines than the St. Paul average rate, does not explain the cause or provide a remedy for the St. Paul's troubles, while too heavily burdened with debt prior to the slump of business in the northwest, and therefore unable to meet fixed charges was forced to seek the protection of the courts.

Had the St. Paul's capital structure prior to the slump of business in the northwest *been* as *now* proposed by the reorganization committee, it is safe to say the recent depression in that section, would not have made a receivership necessary.

Comparison of Six Pacific Coast Lines

To make clear to all students of this question that the St. Paul's troubles were more chargeable to: (a) loss or falling off of business, and (b) entirely too heavy bonded debt, than to the rate structure, attention is invited to the following tabulation of six (6) lines, two of which are the St. Paul's principal competitors, two do not reach the

Pacific coast with their own rails, but do business there through a division of rates and interchange of traffic with other carriers, while one line, the Southern Pacific, lies nearest the Panama Canal of any other Pacific Coast line.

This tabulation speaks eloquently on questions of:

1. Capitalization—amount per mile, particularly the funded debt.
2. Traffic—commodities subdivided.
3. Operating statistics, etc.

Comments on Tabulated Comparison

The average of all six lines is $72,802 per mile, while the St. Paul is only $61.34, it will be noted, however, that the bonded debt of the six lines only averages $37,787 per mile, while the St. Paul is $40,120, an amount entirely too high, and which will, under the present plan of reorganization be scaled down.

The Chicago & Northwestern, one of the old reliable roads of the northwest whose securities have been gilt edged for the past 40 years, not only has a bonded indebtedness of $10,000 less per mile than the St. Paul, but its stock issue is also less, while the comparatively small local line, Chicago Great Western, although apparently capitalized too high, it will be observed the bonded debt is only $27,141 per mile, or $12,979 less than the St. Paul. With the exception of a slight increase in the Southern Pacific and about $7,000 per mile of the Northern Pacific, the bonded debt of the St. Paul is from about $2,000 to $10,000 above all other lines and $3,000 per mile above an average of all six lines, which, under the surrounding circumstances would seem to bear out the claim of the reorganization committee that the bonded debt was too high and must be scaled down.

Traffic

The Interstate Commerce Commission in 1923 made a study of the average return per ton on the following commodities classified below as follows:

1. Products of agriculture $3.23
2. Animals and products 5.33
3. Products of mines 1.21
4. Products of forests 2.08
5. Manufacturers and miscellaneous 2.70
6. Merchandise all L. C. L. 4.40
7. Average of all 4.10
8. Average length of haul .... 172 miles
9. Average receipts per ton miles c 1.125c

The foregoing is an average for the United States, but when considered in connection with the percentages of the different commodities handled by the St. Paul and the other five lines in comparison, it will at once be quite clear, that from a traffic standpoint, the St. Paul has been, and is now, in sore need of a substantial increase of high grade tonnage, rather than wait for the Interstate Commerce Commission to act on a request for increased rates, which of course might not be granted.

The average revenue per ton mile of the above five lines with which the St. Paul is in competition is $.01177, while the St. Paul's average is $.01073 a difference of $.00104, yet it should be oberved that the Chicago Great Western, with only 1496 miles of line and only 35.1% of business originating on its lines, and with an average rate of only $.00978 gets a haul per ton of 292.9 miles and earns $17,194 per mile, while the St. Paul with its 10,987 miles and a rate per ton of $.01073 only gets a haul of 232.2 miles. and earns only $15,406 per mile.

In the matter of passenger rates the average for all six lines is $.03268 per mile, while the St. Paul received .03335 per mile, or about $.00067 more than the other lines, which again shows that the trouble is not with the rate structure, but with the volume of business handled.

Cost Per 1,000 Ton Miles

The average cost per 1,000 ton miles for train and engine service shows favorable to the St. Paul, although when the cost of fuel per ton is considered it will be clear that some of the other lines are doing as well, if not better, as the cost of fuel and quantity used is the important or governing factors in this item of expense.

ROAD	Revenue Car Freight Loads		Revenue Freight Tons		Revenue Per Ton & Length of Haul		Rev. Per Ton Mile
	Originated	Total Carried	Originated	Total Carried	Rev. Per Ton	Length of Haul Miles	
Sou. Pacific	856,171	1,151,443	26,618,543	35,034,224	$3.84	259.1	$.01483
Santa Fe	852,210	1,114,782	26,587,363	33,681,574	$4.21	301.9	$.01397
Union Pacific	321,270	688,508	10,191,456	18,169,301	$5.15	422.6	$.01221
C. & N. W.	1,044,590	1,645,282	33,327,579	52,158,316	$1.94	158.9	$.01223
C. & G. W.	113,580	257,598	2,539,538	6,587,565	$2.86	292.9	$.00978
C. B. & Q.	988,348	1,392,061	30,342,969	42,778,294	$2.90	291.8	$.00996
St. Paul	1,075,806	1,492,038	34,600,959	47,143,747	$2.49	232.3	$.01073
Nor. Pacific	571,843	729,029	19,229,502	23,991,532	$3.21	284.	$.01132
Great Northern	712,997	823,171	28,362,393	31,669,750	$2.57	240.6	$.01070
Totals & Aver.	6,646,812	9,293,911	211,798,302	291,164,303	$3.23	278.	$.01182

Value of Freight Traffic Originating on Line, Total Handled in Car Loads, and Traffic for 1924—Revenue Per Ton, Length of Haul and Revenue Per Ton Mile for 1923

The line with fuel at $2.90 to $3.00 per ton should make a much better showing than lines that pay $4.50 to $5.00 per ton.

Questions of Salesmanship Involved

A casual glance at table No. 1 will indicate to the student of these problems one of the principal troubles, while a careful study of tabulations Nos. 1 and 2 will leave no doubt as to *cause*, *effect*, and probable *remedy*.

One of the most striking features of table No. 1 is the figures for the Chicago & North Western and Chicago Great Western Railways, neither of which go to the Pacific Coast, while the latter has less than 1,500 miles of line and its longest haul is less than 600 miles, yet with this disadvantage, plus the fact that less than 36% of their business originated on their line, we find the traffic department or selling organization of the Great Western has functioned so effective as to secure 64% of their business from *off* their line, and for such a relative long haul on their own rails, that the average haul per ton is 292.9 miles against 232.3 for the St. Paul with almost 11,000 miles of line and almost 2,200 miles of a straight haul from Chicago to Seattle.

A close study of, and comparison with the two above lines and the St. Paul, would seem to justify the conclusion that, while a rate increase would be helpful to all northwestern carriers and should be allowed unless their cost of living can be reduced, the average return per ton and ton mile is subject to a rather wide range of fluctuation, and that this is influenced by the efficiency or degree of success of the traffic or selling department of the carrier in securing long haul tonnage of the commodities yielding the greatest revenue under an existing rate structure common to that territory.

The following table No. 2 shows the volume of freight traffic by car loads and in tons on nine different lines, with which the St. Paul is in competition, for the year

1924, also the respective volume of business originating on line to that secured from other lines, while the revenue per ton handled, the average length of haul in miles, and the yield per ton mile is for 1923.

From a casual glance at table No. 2 it might be inferred that certain lines were more favored than others in the matter of rates, while a careful study of the respective tonnage or volume of the different commodities handled, however, will provide an answer as to the wide range of difference in average revenue per ton of freight.

Summary

The St. Paul, although a splendid property, and one that will in all probability regain its former prestige as the country through which it runs is developed, and with a proper financial structure, is *now bankrupt* and the necessary funds for its rehabilitation cannot be expected from immediate improvement in net earnings, and to farther put off the inevitable with the false hope of relief through favorable action on pending rate questions, is as futile as to postpone an operation for acute appendicitis with the hope of surgeon's fees being reduced.

The bonded debt of the road is apparently *too high* and must be scaled down.

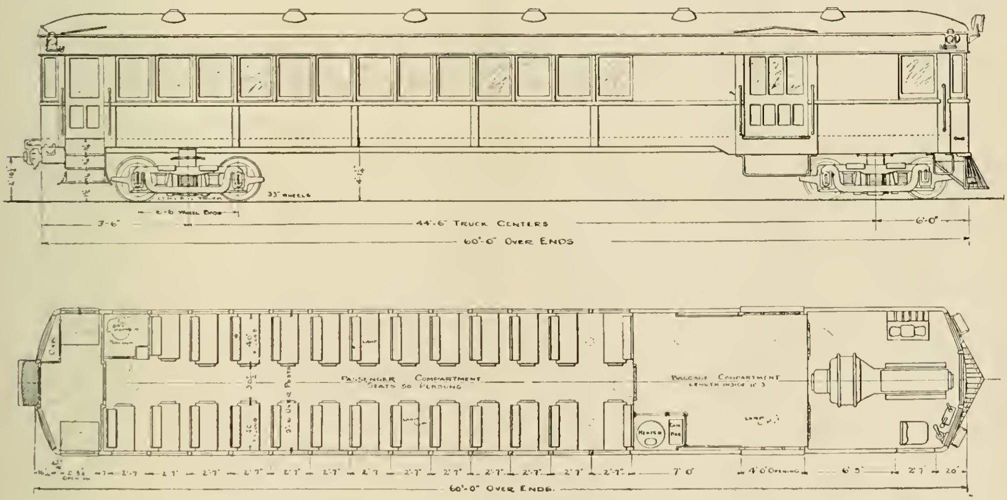
New money is required to meet present obligations and for working capital. The security holders must participate in a plan to meet these ends, and should also provide means whereby the small, or financially embarrassed shareholder will not be forced to lose his equity in the property on account of the assessment.

A New Type Gas-Electric Car for the Reading Company

The car now under construction for the Reading Company will be of the Brill Company's light-weight type, approximately 60 ft. over all length. The width over the posts will be 9 ft. 6 in. The car will be equipped with two trucks, the center distance being 44 ft. 6 in., and the truck wheel base 6 ft. 6 in. There will be a baggage compartment 11 ft. 3 in. in length, a passenger compartment seating approximately 50 passengers, and an engine compartment will be provided at one end of the car. The height from the top of the floor to the top of the roof will be 8 ft. 2¼ in.

couplers having standard A.R.A. contour, and will be fitted with a light type of spring draft gear. The rear end of the car will be provided with a two-stem platform buffer complete with springs and checkered cover plate. The car will be mounted on one Brill No. 27 motor truck and one Brill No. 27 trailer truck, both the motor and the trailer truck to have a wheel base of 6 ft. 6 in. and equipped with 33 in. rolled steel wheels having A.R.A. tread and flange.

The prime mover will be a 250-h.p., 1,100-r.p.m., six-cylinder gasoline engine. It has been designed by the J.



Side Elevation and Floor Plan of Gas-Electric Car of the Reading Company

The car will have straight sides, rounded end and an arched type of roof. It will be very similar in construction to the present standard type of gasoline-rail cars manufactured by the J. G. Brill Co.

The car will be of all-steel construction. The interior will follow conventional lines of construction for this type of equipment. The seats will be reversible, as the car will be equipped for double-end operation. Ample room will be allowed between seats. The cushions and backs will be upholstered in dark brown imitation leather.

This car will be equipped with suitable light-weight

G. Brill Co. and will be built to their specifications. The medium speed of 1,100 r.p.m. has been selected as this permits an exceptionally sturdy engine of light weight and does not involve the high maintenance of high speed engines. It will be built with removable cylinder liners and dual cylinder head. The valves in the head will be operated by rocker arms and push rods. Four valves will be provided to insure long valve life.

The cylinder heads will be cast in pairs, and so designed that any head may be detached without removing the intake or exhaust manifold. The water box will be cast in one piece, flanged and bolted to the top crank case and fitted with removable plates on each side to give access to inspect or remove push rod and guide.

One of the outstanding features of this engine is the size of the crank shaft which has been built to withstand exceedingly severe service. It will be supported on seven main bearings of 4-in. diameter.

The Westinghouse generating unit will be connected directly to the engine through a Thermoid type of coupling. This generator will be of 160-kw. capacity and will be of the two-bearing type. An exciter will be mounted integral with the generator at the commutator end. The generator design follows the practices and utilizes the method and material developed by long years of experience in the construction of rotating apparatus for steam and electric railroads. It will operate at variable voltages up to approximately 600 volts.

The current from the generator passes through the electric traction motors which propel the car. The two motors will be mounted on the forward truck. They will be of the modern type of railway motor used universally for heavy railway service. Each motor will be suspended between the axles and the truck frame, driving its axle through a silent helical gear, the gear ratio between the motor and the axle being 16 to 61. This ratio will permit the car to operate at approximately 45 m.p.h. on a level tangent track and is most suitable for hauling extremely heavy trailing loads. Should a higher operating speed be found desirable, it can be obtained by changing the ratio of the motor gearing, so that speeds in excess of 60 m.p.h. may be obtained.

The control of this car will be incorporated in a master controller, one of which will be mounted at each end of the car. The control will be of the Westinghouse electric-pneumatic type and will embody characteristics which render it exceedingly flexible. The first position of the master controller will connect the electric traction motors to the generator and at the same time will raise the engine speed slightly in order to provide the power for this operation. Further advancement of the controller gradually opens the engine throttle by means of a remote control device, thus causing the engine speed in increase. The increased speed of the engine generator set increases the flow of current to accelerate the traction motors. When the engine is operating at its maximum governed speed of 1,100 r.p.m., the maximum power is being delivered to the generator; however, this maximum power does not mean that the voltage applied to the motors is a maximum, for the characteristics of the generator are such that the engine is protected against overloading by means of a differential field on the exciter. This characteristic prevents the overloading of the engine under any conditions of operation and permits of the operation of two or more cars in a train from any master controller in the train.

The compressor is of the electrically driven type, power for the compressor motor being obtained from the terminals of the main generator. While the engine is idling the voltage is low so that the compressor cannot operate. To insure a supply of air at all times, arrangements have been made so that if the compressor governor cuts in, while the engine is idling, the speed of the engine generator set is raised sufficiently to provide the necessary power for the operation of the compressor. This feature insures a supply of air at all times for the operation of the braking equipment.

A battery will be provided for energizing the exciter field and for providing energy for the car illumination. This battery will be charged through a regulator from the exciter. Starting of the engine will also be accomplished by means of this source of power.

It is expected that the car complete will weigh approximately 70,000 lb., or 82,000 lb. with average load. It will also be able to pull a 150,000 lb. trailing load at 32 m.p.h. on a level tangent track. This tends towards standardization for all classes of branch line service, inasmuch as it is seldom desirable to operate at speeds much higher than 45 m.p.h. and it is often very desirable to handle an additional car, milk car or freight car. Thus, a gear ratio of 16 to 61 as mentioned before, satisfies the average conditions found on branch line roads. However, speeds of over 60 m.p.h. may be obtained with the car operating as a single unit with a higher speed gear ratio. This high speed gear ratio, however, reduces the trailer capacity of the car.

Handling Trains Carefully

The Richmond, Fredericksburg & Potomac has adopted the policy of detailing passenger engineers from time to time, to ride over the road in cars near the rear of the train so that they might actually experience the results of rough handling.

In this way the enginemen are impressed by the fact that the handling of the train, which they ordinarily thought from their position in the engine cab was performed with due caution, as a matter of fact, when affected by long trains with the consequent slack between the cars, was attended with serious discomforts to those far back in their trains.

Having this fact so impressed upon them they have redoubled their efforts on subsequent runs to perfect the handling of their trains.

The plan according to the management has worked out satisfactorily, not only from the standpoint of the actual physical experience of the enginemen from their observation runs but from the factor of psychology which entered into it.

Notes on Domestic Railroads

Locomotives

The Southern Pacific Company will build 10, 6-wheel switchers and 10 cylindrical tenders of 5,200 gallon capacity in their own shops at Houston, Texas.

The Texas & Pacific Railway is reported to be planning the purchase of 20 locomotives.

The New York, Chicago & St. Louis Railroad has placed an order for 10 additional 8-wheel switching locomotives from the Lima Locomotive Works.

The Richmond, Fredericksburg & Potomac Railroad is inquiring for 2 Mountain type, 2 Pacific type and 2 switching type locomotives.

The Lake Superior & Ishpeming Railroad is inquiring for one Consolidation type locomotive.

The Texas Company have placed an order for one 6-wheel switcher with the Baldwin Locomotive Works.

The Baltimore & Ohio Railroad is reported to be planning the purchase of 5, 80-ton electric locomotives.

The National Tube Company is inquiring for 2, 8-wheel switching type locomotives.

The New York, New Haven & Hartford Railroad will erect 10 locomotives in its own shops.

Sao Paulo-Rio Grande Ferrocarril of Brazil has placed orders for 24 Mikado type locomotives.

The Delaware & Hudson Company is inquiring for 10 Consolidation type locomotives.

The McCloud River Railroad has ordered 2 Prairie type locomotives from the American Locomotive Company.

The Paracatu E deF., Brazil, has ordered 2 Mikado type locomotives from the Baldwin Locomotive Works.

The Fulton Iron Works Company is inquiring for one Consolidation type locomotive.

The Delaware, Lackawanna & Western Railroad has ordered 3, 3-cylinder Mountain type locomotives from the American Locomotive Co.

The St. Paul Bridge & Terminal Railway is inquiring for one, 8-wheel switching locomotive.

The New York Central Railroad is inquiring for 10 electric locomotives for passenger service.

Freight Cars

The Great Northern Railway is making inquiry for 200 steel underframes for 50-ft. flat cars of 50 tons capacity also for 1,000 steel underframes for 50-ft. automobile cars of 40-tons capacity.

The St. Louis Southwestern Railway is inquiring for 10 underframes for box cars.

The Buffalo, Rochester & Pittsburgh Railway has placed orders covering the repair of 300 gondola cars with the Buffalo Steel Car Company.

The Carnegie Steel Company are making inquiries for the repair of 400 hopper cars.

The New York, New Haven & Hartford Railroad is making inquiries for 5 drop pit cars.

The Texas & Pacific Railway is inquiring for 500 gondola cars.

The Missouri-Kansas-Texas Railway will repair between 800 and 900 freight cars in its own shops at Galveston, Texas.

The Virginia Smelting Co. have placed an order for one tank car with the American Car & Foundry Company.

The Chicago, Indianapolis & Louisville Railway is inquiring for 400 steel underframes.

The Great Northern Railway is inquiring for 1,000 steel underframes for box cars and 200 underframes for flat cars.

The Southern Pacific Company will construct in its own shops 300 box cars and 20 caboose cars.

The Western Paper Maker Chemical Co. have placed an order for 2, 50-ton tank cars with the Standard Tank Car Company.

The Live Poultry Transit Co., has ordered 50 poultry cars from the Illinois Car & Mfg. Co.

The Cities Service Co. has ordered 75 tank cars from the Standard Tank Car Company.

The Great Northern Railway is inquiring for 250 general service cars of 50 tons' capacity.

The Mineral Point Zinc Co. has ordered 43 mine cars from the American Car & Foundry Company.

The Lehigh & Wyoming Valley Coal Co. has ordered 25 mine cars from the American Car & Foundry Co.

The Southern Railway has ordered 1,000 steel underframes from the Virginia Bridge & Iron Company.

The Ayreshire Coal Co. has ordered 60 mine cars from the American Car & Foundry Company.

The Maderia Hill & Co. has ordered 25 mine cars from the American Car & Foundry Company.

The Cosgrove Meehan Coal Co. has ordered 50 steel mine cars from the American Car & Foundry Company.

The Chicago, Milwaukee & St. Paul Railway has ordered 500 flat cars from the Ryan Car Company, and 500 gondola cars with the Standard Tank Car Company.

The Tennessee Coal, Iron & Railroad Company has ordered 5, 30-yard extension side dump cars from the Clark Car Company.

The Mathieson Alkali Works has ordered 10, 50-ton tank cars, 8,000-gallon capacity, from the American Car & Foundry Company.

The Fruit Growers Express is inquiring for 700 underframes for refrigerator cars.

The Shipper Car Line, Inc., has ordered 150 tank cars of 50 tons and 10,000 gallon capacity from the American Car & Foundry Company.

The General Electric Co., has ordered 2, 30-yard extension side dump cars from the Clark Car Company.

The Chicago, Milwaukee & St. Paul Railway plans building 5,000 freight cars in its own shops.

The Fruit Growers Express has ordered materials for building and for repairing 128 refrigerator cars in their own shops at Portland, Oregon.

Passenger Cars

The New York Central Railroad has placed an order for 20 suburban coaches with the Standard Steel Car Co.

The Pennsylvania Railroad has placed an order for 3 gas-electric cars with the J. G. Brill Co., Philadelphia, Pa.

The Butler County Railroad has ordered one single engine combination passenger and baggage motor car from the Edwards Railway Motor Car Co., at Sanford, N. C.

The Kansas City, Mexico & Orient Railroad has ordered 3 gasoline motor cars and 2 trailers from the J. G. Brill Co., Philadelphia, Pa.

The Marion & Rye Valley Railroad has placed an order for one twin engine gasoline motor car with the Edwards Railway Motor Car Co., at Sanford, N. C.

The Colorado & Southwestern Railway has placed an order for one twin engine combination passenger and baggage motor car with the Edwards Railway Motor Car Co., at Sanford, N. C.

The Boston & Albany Railroad has ordered 20 suburban coaches 70-ft. 4 in. long from the Osgood Bradley Car Company.

The Pittsburgh & Lake Erie Railroad has placed an order for two passenger baggage cars with the Pressed Steel Car Company.

The New York, Ontario & Western Railroad has placed an order for one combination passenger baggage gasoline electric car with the J. G. Brill Co., Philadelphia, Pa.

The Seaboard Air Line Railway has ordered 12 all-steel dining cars from the Pullman Car & Manufacturing Corporation.

The St. Louis-San Francisco Railway has ordered 2 gasoline motor coaches from Sykes Company.

The Chicago, Milwaukee & St. Paul Railway plans the construction of 14 dining cars in its own shops.

The Baltimore & Ohio Railroad is reported to be inquiring for 10 motor cars.

The Alaska Railroad is inquiring for 2 gasoline rail motor cars.

The Chicago, Rock Island & Pacific Railway has ordered 2 buffet-baggage cars from the Pullman Car & Manufacturing Co.

The Maryland & Delaware Coast Railway has placed an order for one combination gasoline rail car and passenger trailer, with the J. G. Brill Co., Philadelphia, Pa.

The New York, New Haven & Hartford Railroad contemplates buying 35 motor cars.

The Baltimore & Ohio Railroad has placed an order for 5 dining cars with the Pullman Car & Manufacturing Co.

The Havana Central Railway is inquiring for 12 second class passenger cars.

Buildings and Structures

The Illinois Central Railroad is inquiring for bids covering the construction of a brick and steel roundhouse, a machine shop and a number of smaller shops at Sioux City, Iowa.

The Atlantic Coast Line Railway has awarded a contract for the construction of shop buildings at Uceta, Fla., to cost approximately $180,000.

The Kansas City Southern Railway plans construction of a new car and locomotive shops at Port Arthur, Texas, to cost approximately $1,250,000.

The Lehigh Valley Railroad plans extensions and improvements to its roundhouse at Lehighton, Pa.

The Missouri Pacific Railroad has plans prepared for the construction of a 15-stall roundhouse and a car repair shop at El Dorado, Ark.

The Baltimore & Ohio Railroad plans the construction at its Mount Clare shops, Baltimore, Md., a concrete steel shelter for locomotive repairs, a stripping shed, and work pits.

The Santa Maria Valley Railway is constructing a roundhouse and other buildings at Santa Maria, Calif.

The Pittsburh & Lake Erie Railroad has awarded a contract covering the construction of a one and two story addition to its roundhouse at Newell, Pa.

The Erie Railroad will convert its Monmouth street, Jersey City, coach yard into a team track yard and will build at Weehawken, New Jersey, a new coach yard.

The Missouri Pacific Railroad has awarded a contract for the construction of a 10-stall roundhouse at St. Louis, Mo., to cost approximately $90,000.

The Atchison, Topeka & Santa Fe Railway has placed a contract covering the construction of a new employees' hospital to be located on the shop grounds at San Bernardino, Calif., to cost approximately $10,000.

The Houston & Texas Central Railroad plans the construction of additions to its roundhouse at Houston, Texas, including the extension of 18 engine stalls and the installation of a 100-feet turntable and a general overhauling of the present facilities.

The Chicago, Milwaukee & St. Paul Railroad has awarded a contract for the erection of a new 30-stall roundhouse at Pig's Eye Lake yards in St. Paul district, to cost approximately $1,000,000.

The Atchison, Topeka & Santa Fe Railway has awarded a contract for the erection of an addition to the engine house at the Ewing Avenue shops at St. Louis, Mo., to cost approximately $60,000.

The Delaware, Lackawanna & Western Railroad plans the construction of a coal storage and distributing plant with shop facilities at Wyoming, Pa.

The Gulf Coast Line Railroad have awarded a contract covering the construction of a storehouse, a machine shop, a power house and an erecting shop, also car repair shed, a sand house, a six stall roundhouse, and wheel shop at DeQuincy, La., by the company's own forces.

The Illinois Central Railroad has awarded a contract for the construction of a water treating plant and pumping station at Harvey, Ill.

The Monongahela Railroad has awarded a contract for the erection of a one-story machine and car shop at Brownsville, Pa.

The Northern Pacific Railway has awarded a contract for a new shop and buildings at St. Paul, Minn. This improvement will cost with equipment approximately $450,000.

The Atlantic Coast Line Railroad plans extensive improvements at its shops at Thomasville, Ga. These include the electric turntable and track extensions.

Items of Personal Interest

William L. Bean, formerly assistant mechanical manager of the New York, New Haven & Hartford Railroad, with headquarters at New Haven, Conn., has been appointed mechanical manager, with the same headquarters, succeeding **L. M. Reed**, resigned. **B. A. Moriarty**, mechanical superintendent, with headquarters at Boston, Mass., has been appointed general mechanical superintendent, with headquarters at New Haven, Conn. **H. P. Hass'** title as special assistant to mechanical manager has been changed to assistant to mechanical manager. **F. E. Ballda**, assistant to mechanical manager, has been appointed mechanical superintendent of lines east, with headquarters at Boston, Mass., succeeding B. A. Moriarty. **Kenneth Cartwright** has been appointed assistant mechanical engineer in charge of specifications, design records, and standards of equipment.

A. McDonald has been appointed acting superintendent of shops of central region of the Canadian National Railways, with headquarters at Montreal, Que., Canada.

I. W. Geer, general manager of the southwestern region of the Pennsylvania Rilroad, has been transferred to Chicago, Ill., as assistant general manager of the western region, a consolidation of the former northwestern and southwestern regions.

M. R. Reed, formerly assistant superintendent of motive power of the northwestern region of the Pennsylvania Railroad, with headquarters at Chicago, Ill., has been appointed master mechanic of the Logansport division with headquarters at Logansport, Ind., succeeding **W. B. Porter**, transferred. **G. B. Fravel** has been appointed assistant general superintendent of motive power of the new western region, with headquarters at Columbus, Ohio.

John T. Grow has been appointed district master car builder of the New York Central Railroad at West Albany, New York, succeeding **G. E. Carson**.

J. J. Tatum, superintendent car department of the Baltimore & Ohio Railroad, has been appointed general superintendent car department, with headquarters at Baltimore, Md.

Louis Yager has been appointed assistant chief engineer of the Northern Pacific Railway, with headquarters at St. Paul, Minn., succeeding **S. J. Bratager. Lowry Smith** has been appointed office engineer, with headquarters at St. Paul, Minn.

J. T. Carroll, general superintendent motive power of the Baltimore & Ohio Railroad, has been appointed general superintendent of motive power and equipment, with headquarters at Baltimore, Md.

John H. Turner, master mechanic of the Chicago & Northwestern Railway, with headquarters at Spooner, Wisc., retired after 44 years' service. **A. E. Johnson** has been appointed assistant car foreman, with headquarters at Fremont, Nebr. **C. C. Ellsworth** has been appointed road foreman of engines, with headquarters at Ashland, Wisc., and **Hans Anderson** has been appointed night roundhouse foreman, with headquarters at Pierre, So. Dakota.

C. S. Kirkpatrick has been appointed chief engineer of the Gulf Coast Lines, International Great Northern Railway, with headquarters at Houston, Texas.

W. H. Truesdale has resigned as president of the Delaware, Lackawanna & Western Railroad, and has been elected chairman of the board of directors, with headquarters at New York, N. Y. **J. M. Davis**, formerly president of the Manning, Maxwell & Moore Co., New York, N. Y., has been elected president, succeeding Mr. Truesdale.

Morris Rutherford, formerly vice-president, has been chosen president of the Lehigh & Hudson River Railway, with headquarters at Warwick, New York, succeeding **L. A. Riley**, deceased.

W. E. Brown has been appointed assistant roundhouse foreman of Coast Line of the Atchison, Topeka & Santa Fe Railway, with headquarters at Winslow, Ariz., and **R. E. Lane** has been appointed roundhouse foreman, with headquarters at Ash Fork, Ariz.

P. J. Colligan, superintendent of motive power of the Chicago, Rock Island & Pacific Railway, with headquarters at El Reno, Okla, has been appointed superintendent of shops at Silvis, Ill., succeeding **S. W. Mullinix**, who died on June 12 in Moline, Ill., following a stroke of paralysis. **W. B. Embury**, master mechanic at the Armourdale shops at Kansas City, Kans., has been appointed superintendent of motive power, with headquarters at El Reno, Okla., to succeed Mr. Colligan.

F. N. Melius has been appointed general superintendent of New York Terminal district of New York Central Railroad and the Ottawa & New York Railway, with headquarters at New York city, succeeding **F. E. Williamson**, resigned.

Frank H. Becherer has been appointed assistant to the mechanical superintendent of the Boston & Maine Railroad, with headquarters at Boston, Mass., succeeding **Daniel A. Smith**, transferred.

Supply Trade Notes

Emmet K. Connelly, vice president and manager of sales of the **New York Air Brake Company** with headquarters at New York City, has been elected also a member of the board of directors.

The U. S. Light & Heat Corporation, Niagara Falls, New York, announces the transfer of **H. A. Matthews**, vice president of the railway sales division to resident vice-president at Detroit. **J. A. White**, vice president sales manufacturers division will supervise the storage batteries department with **R. J. Stanton** sales engineer in direct charge. **J. L. Fosnight**, sales manager arc welder department, will handle the sale of electric arc welders to railroad companies. **A. W. Donop**, district sales manager, Chicago, Ill., will have charge of sales to railroads in the Chicago district, succeeding **H. A. Morrison**, who has resigned. **W. W. Halsey** will continue as district sales manager of the New York City office which was recently removed from the Grand Central Terminal to 161 West 64th Street.

Charles N. Ring, formerly works manager of the **Allied Steel Casting Co.**, Harvey, Ill., has been appointed assistant director of the **Electric Steel Founders' Research Group**, with headquarters at Chicago, Ill., succeeding **W. J. Corbett**, resigned to become secretary-manager of the **Steel Founders' Society of America.**

Thomas O'Leary, Jr., formerly with the **New York Air Brake Company** is now special representative of the general railroad department, **Johns-Manville, Incorporated**, with headquarters at 409 Dooly Block, Salt Lake City, Utah.

W. W. Ballew, electric railway specialist of the **Westinghouse Electric & Manufacturing Co.**, has been appointed division manager for the state of Georgia with headquarters in the Westinghouse Building, Atlanta, Ga.

Marshall A. Carlton has been appointed Baltimore representative of the **Verona Tool Works**, Pittsburgh, Pa., with headquarters at Munsey Building, Baltimore, Md.

The Central Steel Company, Massillon, Ohio, has opened a branch office at W. P. Story Building, Los Angeles, Calif.

J. W. Foster has been appointed sales manager at Baltimore, Md., for the **Linde Air Products Co.** of New York.

The Timken Roller Bearing Company of Canton, Ohio, announces the retirement of **Heman Ely**, vice-president and treasurer from active connection with the company. The board of directors following the retirement of Mr. Ely will consist of **H. H. Timken, W. R. Timken, J. G. Obermier, M. T. Lothrop** and **J. F. Strough** with officers as follows: H. H. Timken, president; M. T. Lothrop, vice-president; H. J. Porter, vice-president; J. F. Strough, secretary and treasurer; **W. A. Brooks**, assistant secretary; **L. M. Klinedinst**, formerly assistant to Mr. Porter becomes general sales manager of the industrial division.

The Davis Brake Beam Co. announces the appointment of **H. E. Passmore** as sales manager, with headquarters at Oliver building, Pittsburh, Pa. Mr. Passmore was formerly connected with the **Grip Nut Co.**

J. M. Davis, president of **Manning, Maxwell & Moore**, New York City, has resigned to become president of the Delaware, Lackawanna & Western Railroad.

Abram F. Huston, president of the **Lukens Steel Company**, has tendered his resignation to accept the chairmanship of the board of directors and **R. W. Wolcott** of New Orleans has been elected president by the board of directors.

F. A. Merrick, vice-president and general manager of the **Westinghouse Electric & Manufacturing Company** with headquarters at East Pittsburgh, Pa., has been elected a director to succeed **A. G. Becker**, deceased. Mr. Merrick also was elected to the board of the Westinghouse Electric International Company.

H. E. Graham, vice-president in charge of sales of the

Illinois Car & Mfg. Company, with headquarters in Chicago, has resigned to become vice-president in charge of sales and operation of the **Standard Tank Car Company**, with headquarters at Sharon, Pa.

O. B. Chandler has been appointed sales manager of the supply distribution branch house of the **Western Electric Company**, at Memphis, Tenn., to succeed **E. P. McGrath**, who has been transferred to the supply distributing house at New York.

John W. Hubbard, Pittsburgh, Pa., head of the **Standard Engineering Co.**, Elwood City, Pa., has acquired the controlling interest in the **Detroit Seamless Tube Co.**

E. M. McLean, sales division manager of the **Four Wheel Drive Auto Company**, Clintonville, Wisc., has been appointed to general sales manager. **S. H. Sanford**, formerly sales division manager, has been appointed assistant sales manager.

C. P. Wright, formerly assistant to the vice-president of the **American Brake Shoe & Foundry Co.**, Chicago, Ill., has been appointed vice-president of the company.

W. B. McSkimmon, formerly vice-president and assistant treasurer of the **Union Twist Drill Co.**, has been elected president to succeed **J. A. McGregor**, deceased.

J. L. Price, vice-president and treasurer of the **Chicago Pneumatic Tool Co.**, has been appointed vice-president and general manager of the newly formed **Bendix Corporation** of Chicago, Ill.

James P. Groome has been added to the sales force of **Manning, Maxwell & Moore, Inc.** He will be attached to the Chicago office of the company.

Obituary

Warren Stanford Stone, internationally known head of the Brotherhood of Locomotive Engineers, died in a hospital in Cleveland, Ohio, on June 12, from an acute attack of Brights disease. His death came as a distinct shock as he had only recently reassumed his duties after a period of illness of several weeks.

Mr. Stone was born on a farm near Ainsworth, Iowa, February 1, 1860. He entered railway service as a fireman in 1879 on the Chicago, Rock Island & Pacific, at Eldon, Iowa, and five years later became a locomotive engineer in which position he remained until 1903 when he was elected grand chief of the Brotherhood of Locomotive Engineers.

At the outset of his career as the leader of a strong labor organization he immediately began to increase the power and prestige of his organization and in which he was eminently successful. During his administration the membership increased from 38,000 to 90,000 and the insurance carried by the members rose from $70,000,000 to over $200,000,000.

He conceived the idea of the new 22-story Brotherhood Bank Building, which was leased to the Brotherhood of Locomotive Co-operative National Bank. It was he who suggested the building of the 14-story Brotherhood of Engineers' Building in Cleveland, which paid for itself in 10 years, and which is valued at $3,000,000.

In 1920 the first engineers' co-operative bank was opened in Cleveland. Three years later its resources were nearly $25,-000,000, then followed the establishment of other banks throughout the country controlled by the Brotherhood. In addition, large holdings were acquired in the Empire Trust Company of New York, so that the Brotherhood controls interest in financial and industrial corporations with assets of approximately $150,000,000.

The multiplication of the organization's financial and industrial undertakings required a reorganization and at the triennial convention in June, 1924, a new office was created—that of president of all of the Brotherhood's activities when Mr. Stone was elected president for a period of six years.

Mr. Stone has long been recognized as America's foremost labor leader. He was active in labor union development from a period of strife to a period of co-operation with management. As all labor leaders, he fought for immediate benefits for his brotherhood, but he also directed his union into new paths which lead to greater power and permanent prosperity for his organization.

Mr. W. B. Prenter, who has been grand secretary-treasurer of the Brotherhood of Locomotive Engineers since 1904 has been elected to succeed Mr. Stone.

Julius Kruttschnitt, chairman of the executive committee of the Southern Pacific Company, who retired on June 1st of this year, died in a New York City hospital on June 15, as the result of a heart attack which he suffered following a minor operation. Mr. Kruttschnitt was born in New Orleans, La., on July 30, 1854, and graduated from Washington and Lee University in the class of 1873, as a civil engineer. He entered railway service in 1878 as engineer of extension on Morgan's Louisiana & Texas Railroad and Steamship Company. He was appointed road master of the Western division in 1880, and in 1881 assistant chief engineer and general roadmaster. In 1883 he was appointed chief engineer and superintendent. In 1885 he was appointed assistant manager of the Atlantic system of the Southern Pacific Company and four years later he was appointed general manager and vice-president of the Galveston, Harrisburg & San Antonio Railway and the Texas & New Orleans Railroad. In 1895 he was appointed general manager of all lines of the Southern Pacific Company, and in 1898 he was also elected vice-president. Mr. Kruttschnitt was appointed director of maintenance and operation of the Union Pacific Railroad and the Oregon Short Line Railroad, the Oregon-Washington Railroad & Navigation Co., and the Southern Pacific Company, and in 1913 he was appointed chairman of the executive committee of the board of directors and a director of the following lines: Southern Pacific Company, Arizona Eastern Railroad, Galveston, Harrisburg & San Antonio Railway, Houston & Shreveport Railroad, Houston & Texas Central Railroad, Houston, East & West Texas Railway, Louisiana Western Railroad, Morgan's Louisiana & Texas Railroad. From February, 1913, he has also been director of the Southern Pacific Terminal Company; from April 1913, also president and director of the Sonora Railway; July 1913, also a director of the Northern Pacific Terminal Company of Oregon; from November, 1913, also president and director Rockaway Pacific Corp.; from October, 1917, also a director Erie Railroad; July 1919, also a member of the executive committee of the Erie Railroad; April, 1918, also director and member of the executive committee of the Western Union Telegraph Company.

S. W. Mullinix, superintendent of shops of the Chicago, Rock Island & Pacific with headquarters at Silvis, Ill., died on June 12 in Moline, Ill., following a stroke of paralysis. He was born in Frederick County, Md., in 1859. He served his apprenticeship in the shops of the Baltimore & Ohio Railroad, and later became machine shop foreman of the Chesapeake & Ohio Railroad at Huntington, W. Va. From Huntington he went to Louisville, Ky., and later to Paducah as master mechanic for the Newport News & Mississippi Valley Railroad, now part of the Illinois Central Railroad. After a brief period with the Louisville & Nashville Railroad as roundhouse foreman at Louisville, he was appointed general foreman of the Central Vermont Railroad with headquarters at St. Albans, Vt. In 1903 he became master mechanic for the Kansas City Southern Railway at Pittsburg, Kansas. In 1905 he was made master mechanic of the Atchison, Topeka & Santa Fe Railway at Raton, N. Mex. He joined the forces of the Chicago, Rock Island & Pacific Railway in 1906 as district mechanical superintendent at Topeka, Kansas. In 1913 he was made superintendent of the Silvis shops, in which capacity he was serving at the time of his death.

H. Englebright, retired master car repairer of the Southern Pacific Company, died at his home at Oakland, Cal., on June 5, at the age of 73. Mr. Englebright was born in New Bedford, Mass., on June 10, 1852, and was taken to California by his parents at the age of five. He entered the service of the California Pacific Railroad in 1869, as blacksmith apprentice and worked as apprentice and blacksmith at various points until 1892, when he was appointed roundhouse and car foreman at Fresno, Cal. In 1898, he was appointed general car foreman at San Francisco, and, in 1900, he was promoted to master car repairer at Oakland, Cal., which position he held until the time of his retirement in August, 1922.

Wayne W. Smith of Schenectady, New York, traveling engineer for the American Locomotive Company, died suddenly in Cincinnati, Ohio, on June 13.

New Publications

Books, Bulletins, Catalogues, etc.

Flannery Staybolt Catalog. Flannery Bolt Co., Pittsburgh, Pa. 8½ in. by 11 in.; 53 pages.

This is an elaborately illustrated catalog in which the many designs of the flexible staybolt manufactured by the Flannery Bolt Company are set forth. One of the interesting illustrations is that of the application of the Universal Welded type of sleeve to the wrapper sheet, showing how the bolt may be set at a very sharp angle with that sheet in order to stand square with the crownsheet, and yet have a normal bearing on its own sleeve. This is shown both in line and half tone engravings.

The tools to be used in the application of the bolts, such as the counterboring reamers, the sheet cleaners, bolt drivers, etc., are also fully illustrated and described.

This is followed by three pages of instructions as to the methods to be followed in installing welded sleeves.

Then there are illustrations of the various types and styles of bolts, with a rule for obtaining their lengths and instructions for the selection of Tate parts.

The book ends with bolt illustrations and a description of the electric tester for staybolts that was illustrated and described in Railway & Locomotive Enginering for August, 1923.

Superheat Engineering Data. A handbook on the generation and use of superheated steam. Sixth Edition Revised. (Superseding Data Book for Engineering.) The Superheater Company, New York and Chicago, 1925. Bound in Keratol, 4½ x 7 in., 208 pages, 85 illustrations and diagrams, 69 tables. Price $1.00.

This handbook contains condensed data for steam power plant engineers and operators. A feature of the book is the index consisting of 16 pages, assuring ready reference. Superheated steam, its advantages over saturated steam, and the design and performance of superheaters, are briefly discussed. It illustrates superheater arrangements in practically all stationary, marine and locomotive type boilers commonly made in America. Waste heat, portable and separately fired superheaters are also shown. Brief comparative data is given as to sizes, tube sizes, arrangement of tubes, etc., for the stationary water tube boilers illustrated. The steam tables cover pressure from below atmospheric to 600 lbs., absolute, and include properties of superheated steam from 50 to 300 deg. F. superheat.

The section on piping includes information for figuring piping for handling water, saturated and superheated steam, and velocity and pressure drop of water and steam flowing through piping. In this section is included also the proposed American standards for high pressure. Superheat Engineering Data also contains engineering data on coal and oil fired boilers, which include tables of heat values for gaseous, liquid and solid fuels. Other miscellaneous data include complete conversion tables and data on bolts and screw threads, with the recent work of the American Engineering Standards Committee, and the National Screw Thread Commission. There are also many miscellaneous tables frequently used by steam engineers.

Locomotive Feed Water Heaters. The Superheater Company, New York.

This catalogue is a fine example both in matter and appearance of an elementary treatise on steam production and its utilization in a locomotive. It carries a lesson that it is well to drive home again and again as to the inefficiency of the steam engine, an inefficiency that can only be slightly decreased in comparison with the inevitable waste.

This inefficiency and its possible reduction by the use of a feed-water heater is set forth in a series of diagrams that are worthy of careful attention. One diagram represents two Mikado locomotives, one with and the other without a feed-water heater. They each indicate that all the locomotive has to show for the cost of the coal put into the firebox is $63.00 worth of drawbar pull. In the case of the locomotive without the feed-water heater it appears that $900.00 worth of coal is put into the firebox monthly. This is accounted for as follows:

Air pump, radiation, etc.	$90.00
Hot gases from stack	225.00
Exhaust steam	522.00
Drawbar pull	63.00
	$900.00

The accounting of the locomotive with the feed-water heater is:

Air pump, radiation, etc.	$90.00
Hot gases from stack	207.00
Exhaust steam	432.00
Boiler feed pump	18.00
Drawbar pull	63.00
	$810.00

Which is to say that a feed-water heater saves $90.00 a month or 10 per cent of the cost of coal.

Another diagram shows what this 10 per cent will amount to in a year, on locomotive burning from 2,500 lbs. to 4,000 lbs. per hour, and working 250 hours a month, with coal costing from 50 cents to $5.50 a ton.

Then there are other diagrams that present the same thing in other ways.

One diagram serves to show very clearly the heat absorbtion by the water in its progress from the cold condition to steam temperature, its conversion into steam and the superheating of the steam. All of which is familiar to students but is not always appreciated by those on whom the operation of the locomotive devolves.

The diagrams are accompanied by explanatory text that is very readable and simply explicit, so that the whole might well be used as a text book for the instruction of locomotive engineers and firemen.

Copies of the catalogue may be secured on application to the Superheater Company, 17 E. 42nd St., New York.

Railway and Locomotive Engineering

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A New Mountain Type Locomotive for the Baltimore & Ohio Railroad

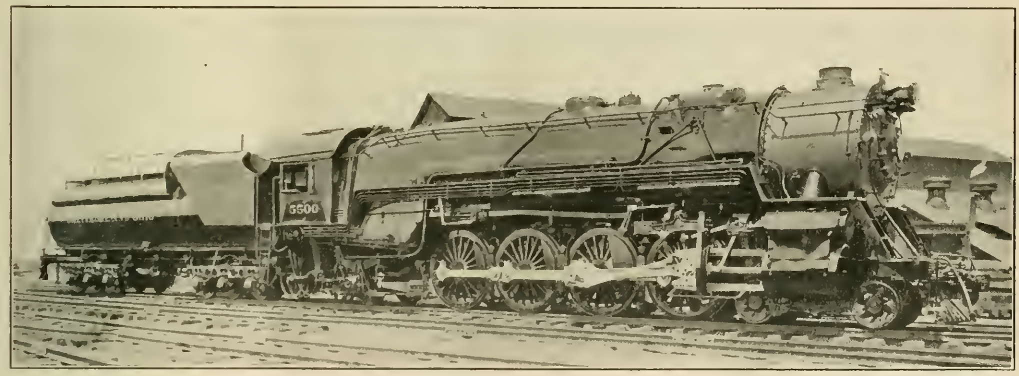
An Interesting Development Using the Santa Fe Type as a Base

The Baltimore & Ohio Railroad has started on the execution of a program of reconstruction and conversion whereby small and partially obsolete locomotives are to be converted into types that will meet the demands of present traffic requirements. In 1924, seven Consolidation locomotives were converted into eight-wheeled switchers, and seventeen Mikados were converted into Pacifics. In addition to this twenty-nine locomotives were converted to more powerful engines of the original types, of which twenty-three were Consolidations, one of which was changed to a switcher. The total cost of these changes and conversions was $1,587,954.00. The program that has been laid down for 1925 is much more elaborate and involves an expenditure of $7,403,830.00, the execution of which is dependent upon the maintenance of revenue at the estimated height.

It involves the conversion of one hundred Consolidation locomotives to switchers, and the change of fifty more to a heavier class. In addition to this, it is planned to convert one thousand steel gondolas into flat cars.

To this program has been added the conversion of a Santa Fe (2-10-2) type freight locomotive into a Mountain (4-8-2) type passenger engine. The conversion, which amounts to a practically new machine, has been executed in accordance with designs worked out under the personal supervision of Col. George H. Emerson, chief of motive power and equipment, and the work was done in the Mt. Clare shops of the company in Baltimore.

The underlying motive for the design was the demand for a more powerful locomotive to haul the heavy passenger trains over the mountains between Cumberland and Pittsburgh and Cumberland and Grafton. On the westward run the maximum grades between Washington and Cumberland do not exceed about 80 feet to the mile, but between Cumberland and Grafton there is a grade of about 105 feet to the mile making an increase of nearly 40 per cent in gravity resistance, so that the performance reports on this grade will be watched with considerable interest. The grades west from Cumberland are less on the line to Pittsburgh than to Grafton where for 48 miles they average nearly 40 feet to the mile with a run of about 17 miles on a grade of over 100 feet. The time for the heavy trains consisting of 12 steel cars up this grade is about seventy minutes for the 48 miles or approximately a little more than 40 miles an hour. And it is expected that this locomotive will do this work without helper service.



Mountain Type Locomotive of Baltimore & Ohio Railroad Constructed at Mt. Clare Shops of the Railroad Company

The new design is built around the old Santa Fe boiler which had a total evaporative and heating surface of 6,836 sq. ft. and carried a steam pressure of 180 lbs. The changes made in the boiler consist principally in lengthening the combustion chamber from 30 7/16 in. to 48 9/16 in. without any shortening of the tubes, and increasing the steam pressure to 210 lbs. per sq. in.

The water capacity of the tender was also increased from 9,700 gals to 15,100 gals, an increase of about 44,-800 lb. in the load to be carried, which together with the additional weight involved in the tender itself required the use of six-wheeled trucks.

Other changes in the engine were an increase in the diameter of the driving wheels from 58 in. to 74 in. In spite of this increase, the dropping of one pair of drivers made it possible to cut down the driving wheel base from 21 ft. to 19 ft. 3 in., which added materially to the flexibility of the machine, though because of the use of a four-wheeled leading truck and the increase of the distance from the rear driver to the trailing truck wheel from 9 ft. 6 in. to 10 ft. 1 in. the total wheel base of the engine was increased from 40 ft. 3 in. to 41 ft. 4 in. which is an insignificant amount.

The designing of the engine was started in the early part of this year. The construction was started on May 16, and completed on June 30, 1925, or in a total of 30 working days.

The engine is designed to traverse curves of 16 degrees. It is 100 ft. 6 in. long over all, and has a total wheel base for the engine and tender of 89 ft.

The locomotive is equipped with the Ragonet reverse gear, air operated cylinder cocks, pneumatic bell ringer, Duplex stoker, superheater, low pressure, compound air pump, cast steel front engine truck, drifting valves, cast steel tender truck and frame, radial buffer between the engine and tender. Unit safety pulling bar and pneumatically operated fire door.

Further particulars of this interesting locomotive is given in the accompanying table of dimensions, weights and proportions.

Table of Weights and Dimensions of Mountain Type Locomotive of Baltimore & Ohio Railroad

Type	4-8-2
Service	Passenger
Fuel	Bitum. Coal
Cylinders, diam. and stroke	30 in. by 30 in.
Valve gear	Baker
Valves:	
Type	Piston
Diameter	14 in.
Maximum Travel	7 in.
Outside Lap	1⅛ in.
Lead in Full Gear	¼ in.
Exhaust Clearance	3/16 in.
Cutoff in Full Gear	88%
Clearances:	
Maximum Height	15 ft. 5⅜ in.
Maximum Width	10 ft. 8 in.
Length Overall	100 ft. 6 in.
Wheel Base:	
Driving	19 ft. 3 in.
Locomotive	41 ft. 4 in.
Tender	33 ft. 4 in.
Total Locomotive & Tender	89 ft.
Weights in working order:	
On drivers	275,000 lbs.
On front truck	62,000 lbs.
On trailing truck	63,000 lbs.
Total locomotive	400,000 lbs.
Tender	259,000 lbs.
Total Locomotive & Tender	659,000 lbs.
Wheels—Diameter Outside Tires:	
Engine Truck	33 in.
Driving	74 in.
Trailing truck	46 in.
Journals—Diameter and Length:	
Driving—Main	13½ in. by 15 in.
Driving—others	11 in. by 13 in.
Front truck	7 in. by 12 in.
Trailing truck	8 in. by 14 in.
Boiler:	
Type	Wagon Top
Steam Pressure	210 pounds
Diameter—First ring inside	90 in.
Diameter—Largest course outside	100 in.
Firebox—Length inside sheets	132¼ in.
Firebox—Width inside sheets	96 in.
Comb. Chamber, Length	48 9/16 in.
Tubes, No. and Diameter	269—2¼ in.
Flues, No. and Diameter	48—5½ in.
Length, Tubes and Flues	23 ft.
Grate Area	89.17 sq. ft.
Heating Surfaces:	
Firebox—Arch Tubes, Combustion Chamber	383 sq. ft.
Tubes and Flues	5,208 sq. ft.
Total	5,591 sq. ft.
Superheating	1,305 sq. ft.
Total combined	6,896 sq. ft.
Tender:	
Type	Vanderbilt
Coal Capacity	18 tons
Water	15,100 gals.
Trucks	6-wheel
Wheels—Diameter	33 in.
Journal—Diameter & Length	6 in. x 11 in.
General data:	
Rated Tractive Power	65,000 lbs.
Factor of Adhesion	4.23

New 2-10-4 or "Texas" Type Locomotive

The Texas and Pacific Railway have ordered ten locomotives of a new type from the Lima Locomotive Works. They are practically duplicates, with the addition of another pair of drivers, of the Lima 2-8-4 two cylinder design. The new locomotives will have two cylinders and a 2-10-4 wheel arrangement and will be known as the "Texas" type.

The following features of design which have proven so successful on the 2-8-4 or A1 type will be incorporated in the new locomotives: Articulated four wheel trailing truck; Lima design of cast steel cylinders with direct outside steam and exhaust passages; Special Lima design of rod drive to distribute piston thrust over four main outside crank pins; Limited Cut-Off to save fuel; Type "E" Superheater; Feed Water Heater and Locomotive Booster.

The new "Texas" Type combines all the proven economies in locomotive design and represents the high point in steam locomotive development to date.

Locomotive Inspection in 1925

During the first six months of 1925, 40,321 locomotives were inspected by the Bureau of Locomotive Inspection of the Interstate Commerce Commission, of which 18,151 were found defective and 1,910 were ordered out of service, according to the commission's monthly report to the President on the condition of railroad equipment. During June 7,381 locomotives were inspected, of which 3,044 were found defective and 292 were ordered out of service. The Bureau of Safety during the same month inspected 95,215 freight cars, of which 2,709 were found defective, and 2,011 passenger cars, of which 23 were found defective.

During the month 16 cases, involving 32 violations of the safety appliance acts, were transmitted to various United States attorneys for prosecution.

Four-Cylinder, Compound Superheated Steam Express Locomotive for the Northern Railroad of Spain

Designed to Operate Passenger Trains of 400 Tons Weight in Mountainous Country—Probably Most Powerful Locomotive in Europe

Because of the steady yearly growth of the traffic between Irun and Madrid, the Northern Railroad of Spain (Cia. de los Caminos de Hierro del Norte de España) found it necessary, in 1924, to build the heaviest express passenger locomotive that had, up to that time, been in use upon its lines.

It may be stated here that this line traverses the most extraordinarily adverse geographical conditions to be found anywhere upon the Iberian peninsula. Starting at the French frontier the Pyrenees must be climbed, that is the Cantabrian mountains, where an elevation of 3,150 feet must be overcome; and later there are the Guadalajara mountains with a height of 3,985 feet, both lying on the route to the frontier station of Irun. There are only a very few large cities on this route, so that, as the express trains serve, for the most part, the international traffic only, it would be uneconomical to increase the number of trains. And so, because of this character of the traffic it is planned to equip the trains with dining, sleeping and saloon cars. This plan could not be executed because the most powerful locomotives that had been built, that is locomotives of the 2 C1 class were not strong enough, while the driving wheels of the 2 D locomotives were too small to make the required speed even on the easiest grades between Burgos and Medina del Campo.

Now while the 2 C1 four-cylinder compound locomotives can only haul a train of 170 tons, the Northern Railroad Company laid down in their specifications that this locomotive should haul a train weighing 440 tons (400 metric tons), at the speeds specified, up the following grades:

On a .5 per cent grade at a speed of 56 miles per hour.

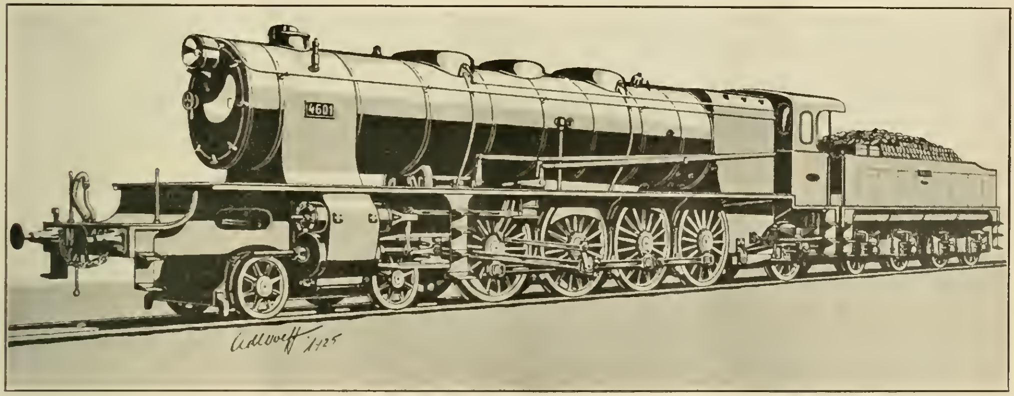
On a 1.1 per cent grade, at a speed of 40 miles per hour.

On a 1.35 per cent grade at a speed of 34 miles per hour.

The fuel used is of a good quality and contains about 12,600 B.t.u. per pound, but has the disadvantage of containing about 12 per cent of ash. It was further specified that the axle loads should not exceed 35,200 lbs. and that the weight of the locomotive and tender including the impact of the counter-balance, in working order, should not be more than 4,025 lbs. per running foot, when measured between the buffers.

After a preliminary examination of the road it was decided that the axle arrangement of the 2 D1 class should be retained and that a four-cylinder de Glehn compound should be used.

It happened that the contract for the construction of the locomotive thus specified was awarded to the Hanomag Works in Munich, Germany, because of their having built several of the suggested type of engines. The 2 D1 type was first brought out in the United States in 1911 by the construction, for the Chesapeake & Ohio Ry., of what is known as the Mountain type (4-8-2), and which can now be almost considered to be the standard type for heavy, high speed passenger service in a mountainous country. So that it appears that this locomotive for the Northern Railroad of Spain was the first of its type to be built for service on the continent of Europe, anticipating those for the Western and Paris, Lyons & Mediterranean railways of France, that have since been built.



4-8-2 Mountain Type Locomotive of the Northern Railway of Spain—From a Drawing in "Hanomag-Nachrichten"

By referring to the table of principal dimensions given at the conclusion of this article a clear idea can be obtained of the size of this locomotive, which is claimed to be the most powerful in Europe. The above-mentioned French engines exceed the Spanish locomotive considerably in weight and yet the dimensions of the boiler and working parts are slightly smaller. If we compare the tractive effort with the individual weights, we will find the Spanish to be considerably superior to the French locomotives.

In order that a locomotive of the specified tractive power should not exceed a weight of 204,600 lbs. when empty, it was necessary that it should be designed with painstaking care, so that the product should conform strictly to the requirements laid down.

It is the expectation, later, to be able to publish the details of the cost of maintenance of the machine as well as an account of the results of tests to which it will have been subjected.

It may be stated here that the boiler is of the Belpaire type with the flat surfaces of the back head through stayed. The copper firebox has a combustion chamber 35¾ in. long, after the American pattern, in order not only to carry the weight forward so as to secure a proper distribution of the load upon the axles, but to obtain as large an amount of direct heating surface as possible. The staying of the firebox is done partly with rigid staybolts and partly by the spherical headed flexible bolts of the Tate design. The shell of the boiler consists of three courses, of which the two front ones are cylindrical and the back one is conical on the under side so as to accommodate the combustion chamber. The maximum inside diameter of the boiler is 76¾ in.

The Schmidt superheater is carried in 30 flues each 4.9 in. inside diameter and 5/32 in. thick. With the center of the boiler set 9 ft. 6 in. above the top of the rail, there was no room to place the Coale pop safety valves vertically on the top, so that they were attached radially to the rear dome.

The preference of the Northern of Spain being for plate frames, they were so made and were formed of through plates about 55 ft. 9 in. long and 1 3/16 in. thick. The cross bracing of the two plate frames, by which they are tied together, aside from the casting of the low pressure cylinders and the front buffer beam, is effected by cast steel braces only.

The front four-wheeled truck is attached by a ball and socket pin that can act as a pendulum, so that the inclined position, which it can assume, in passing curves, automatically provides for the necessary flexibility. The side play of this truck is 3.9 in. on each side of the center. The rear or trailing wheels are placed in an American frame truck and the journals run in oil boxes packed with waste of the "Isothermos" brand. Because of the load on the rear trailing axle it would be apt to run hot, to avoid which the journal has been made of very liberal dimensions. Its length is 14 in. and its diameter 6 11/16 in. The truck frame has a side play of 2 9/16 in. The springs of the driving axles are connected together and with the trailing truck axle by equalizing levers.

Because of the satisfactory experience on the part of the Northern Railroad of Spain with the de Glehn four-cylinder compound locomotives, these engines were fitted with separate valve gearings for the high and low pressure cylinders. The two low pressure cylinders which have a diameter of 27 9/16 in. lie between the frames and are cast with a saddle to carry the smokebox. The high pressure cylinders are on the outside of the low pressure cylinders and are set horizontally. They drive the two main pins through connecting rods 10 ft. 10 in. long, while the low-pressure cylinders are set on an incline of one in 10.6 and drive the front double crank axle through connecting rods 78¾ in. long. The low pressure connecting rod length of 78¾ in. gives a ratio of about 5.9 to one with the radius of the crank.

Air-operated shifting valves are built into the low pressure cylinder casting, by means of which, in case of necessity, the high or low pressure cylinders can be worked alone. The four Hensinger valve gears work with a link coupled on one side. Large air admission and pressure equalizing valves make a smooth running of the locomotive possible when the throttle is closed.

In order to lessen the weight all axle, crank and coupling pins, valve rods, etc., are made hollow.

The special appliances with which the locomotives are equipped are as follows:

Worthington feed water heater having a capacity of 68 gallons per minute; non-lifting Friedmann injector with a capacity of 77 gallons per minute; Smith & Wagner's regulating valve; Equi shaking grates; finger grates; Gresham air sanders connected with the hand sanders; Hardy vacuum brakes with Super-Danton ejector; Hasler's speed indicator; Detroit condensing lubricator with eight outlets; Baldwin-Sunbeam electric lighting equipment with turbo-generator and headlight.

The standard four-axled 6,600 gallon tender of the Northern of Spain railway is used with these engines.

It may be noted, in conclusion that the total length of the engine and tender over buffers is 93 ft. 6 in.

The following are some of the principal dimensions of these locomotives:

Gauge of track	5 ft. 6 in.
Cylinder diameter, H. P.	18⅛ in.
Cylinder diameter, L. P.	27-9/16 in.
Stroke of piston	26¾ in.
Diameter driving wheels	68⅞ in.
Diameter front truck	33⅞ in.
Diameter trailing truck	48⅝ in.
Rigid wheel base	18 ft. 2½ in.
Total wheel base	41 ft. 7 in.
Steam pressure	244 lbs. per sq. in.
Grate area	53.8 sq. ft.
Heating surface, firebox	168.6 sq. ft.
Heating surface, combustion chamber	96.9 sq. ft.
Heating surface arch tubes	28.0 sq. ft.
Heating surface, total firebox	293.5 sq. ft.
Heating surface, tubes	1501.6 sq. ft.
Heating surface, flues	701.5 sq. ft.
Heating surface, total evaporative	2496.6 sq. ft.
Heating surface, superheater	882 sq. ft.
Heating surface, total boiler	3378.6 sq. ft.
Length of tubes, between sheets	18 ft. 8⅞ in.
Diameter superheated flues (inside)	4.9 in.
Diameter tubes (inside)	2 in.
No. of superheater flues	30
No. of tubes	155
Smallest inside diameter of boiler	68⅞ in.
Largest inside diameter of boiler	76¾ in.
Height of center of boiler above top of rail	9 ft. 6 in.
With 5 in. depth of water over crown sheet, water in boiler	2,774 gals.
Steam space	157.2 cu. ft.
Evaporating surface of water	163.9 sq. ft.
Weight, empty	204,600 lbs.
Weight on driving wheels	140,800 lbs.
Weight in working order	226,600 lbs.
Maximum speed	68 m.p.h.
Total length of locomotive without tender, between rubbing plate and buffers	55 ft. 9 in.
Total length of locomotive and tender between buffers	93 ft. 6 in.

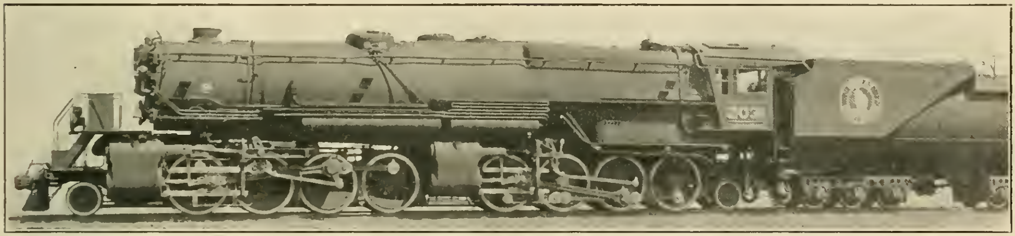
Decrease in Stored Locomotives and Those Needing Repairs

Class 1 railroads on July 15 had 11,224 locomotives in need of repair, 17.5 per cent of the number on line, according to reports filed today by the carriers with the car service division of the American Railway Association. This was an increase of 307 over the number in need of repair on July 1, at which time there were 10,917 or 17.1 per cent. Of the total number, 6,101 or 9.5 per cent were in need of classified repairs, an increase, compared with July 1 this year, of 269, while 5,123 or 8 per cent were in need of running repairs, an increase of 38 within the same period.

Serviceable locomotives in storage on July 15 totaled 6,531, a decrease of 69 compared with the number of such locomotives on July 1.

2-8-8-2 Type Locomotives for the Great Northern Railway

The Great Northern has recently received, from The Baldwin Locomotive Works, four high pressure articulated locomotives of the 2-8-8-2 type which are the most powerful single expansion locomotives thus far completed by the builders. These locomotives, designated by the Railway Company Class R-1-S, are intended for operation between Cut Bank and Whitefish, Montana, a distance of 128 miles, where the line crosses the Continental Divide. The ruling grade approaching the summit west-bound is one per cent, while east-bound it is 0.8 per cent with a pusher grade of 1.8 per cent, 13.8 miles long. The elevation at the summit is 5,211 ft. The sharpest curves on this section of the line are of ten degrees, although the locomotives are designed to traverse curves as sharp as 20 deg.



2-8-8-2 Type Articulated Single Expansion Locomotive of the Great Northern Railway

Since the latter part of 1923, the heavy freight traffic on this division has been handled principally by locomotives of the 2-10-2 type, (Class Q-1), which were built by The Baldwin Locomotive Works. These locomotives develop a tractive force of 87,100 lbs. Four of them, which are equipped with boosters, giving a maximum starting tractive force of nearly 100,000 pounds, are used as pushers on the 1.8 per cent grade. As compared with the road engines of the 2-10-2 type, the new articulated locomotives show an increase in tractive force of nearly 47 per cent.

The largest articulated locomotives heretofore used by the Great Northern are the 25 Mallet Compounds of the 2-8-8-0 type known as Class N-1, which were built by The Baldwin Locomotive Works in 1912. During the past year a number of these locomotives were changed to use high pressure steam in four equal sized cylinders, and the design of the new locomotives was determined after experiments had proved that a material increase in hauling capacity was thus obtained. Track conditions on the Great Northern have been much improved since the Class N-1 locomotives were constructed, and with the wheel loads now permitted it is possible to apply a boiler of sufficient capacity to insure an abundant supply of steam for the four 28 x 32 in. cylinders used on the Class R-1-S.

In accordance with the usual practice on this road, the boiler of Class R-1-S is of the Belpaire type. The barrel has a conical connection, and is 100 in. in diameter at the front end, the maximum diameter being 109 in. It is fed by one Sellers non-lifting injector placed on the left side, and by one Elesco exhaust steam injector on the right side. The combustion chamber has a length of 72 in. and the tubes are 24 ft. long. The locomotives as built are equipped for oil burning, but the design is so worked out that they can subsequently, if desired, be equipped to burn coal and fitted with arches and mechanical stokers. At present no arch tubes are applied, but a brick wall is placed across the throat of the combustion chamber.

Flexible staybolts are applied in the breaking zones in the sides of the firebox. Hollow stays are used in the back head and back of the brick work, and there is a complete installation of flexible bolts in the firebox throat and the combustion chamber.

The main dome is on the third boiler ring, and back of it, on the same ring, is a man-hole opening fitted with a depressed cover, in which are mounted the whistle and the four safety valves. This arrangement was necessary in order to keep within the over-all height limit.

A throttle valve of the Baldwin balanced type is placed in the main dome, and is connected with the superheater header in the smoke-box by means of an internal dry pipe. The steam pipes leading from the superheater header terminate in a second header, placed transversely in the bottom of the smokebox and having connections with two outside steam pipes which lead back to the rear cylinders. The front cylinders receive their steam supply through a centrally located pipe connected to the same header, and having three ball joints. All slip and ball joints are lubricated. Oil cups are used on all packings.

The exhaust from the two front cylinders is conveyed to the nozzle through a pipe placed on the center line, and fitted with two ball joints lubricated with oil, and one slip joint lubricated with grease. The exhaust pipe from the rear cylinders is placed on the left side, and it terminates in an annular opening surrounding the exhaust nozzle of the front cylinders.

The steam supply for the Elesco exhaust steam injector is taken from the exhausts of both the front and rear cylinders. This injector is placed under the cab, on the right-hand side.

The frames are six in. wide, spaced 41 in. apart transversely. Special attention has been given to the design of the articulated frame connection. The vertical hinge pin is six in. in diameter, and is held rigid in the rear cylinder saddle, being secured from turning by a tapered fit and a heavy tapered key. The saddle is bushed and the pin is case-hardened. By holding the pin rigid, the wear is taken by the bushed connecting bar, which can be easily rebushed; and thus the slack between the two units can be kept at a minimum.

Both the vertical and horizontal hinge pins are internally lubricated with grease, which is applied from an easily accessible outside location.

The four cylinders are cast iron and are interchangeable, as are also the front and back pistons, crossheads and connecting rods. Corresponding crank pins, wheels and axles in the front and rear units interchange also. The steam distribution is controlled by 14-in. piston valves which are operated by the Walschaerts valve gear. A Ragonnet type B power reverse mechanism is applied. The reach rod connecting the front and back reverse shafts is placed on the center line of the locomotive, with its joint immediately above the articulated frame connection. In this way there is practically no distortion to the movement of the forwad valves when the locomotive is traversing a curve. The valves all have 1⅞ in. steam lap and no exhaust clearance, and are set with a travel of 6¾ in. and a lead of 3/16 in. The cut-off when working in full gear, is 65 per cent.

The piston heads are steel of the solid type, fitted with bull rings and packing rings of B. L. W. special iron. The main crank pins are of vanadium steel, hollow bored. With the exception of the front main rod stubs, solid end stubs with floating bushings are used throughout. All the pins are lubricated with grease.

The boiler is supported on the front frames by means of a single bearer, located to give an even weight distribution and designed to distribute the load on the frames with a minimum frame stress. A low bearing pressure per square inch is assured by the liberal bearing area provided, and the bearer is designed to permit a rocking movement of the frames without binding. No centering device is applied, experience having proved that its use is unnecessary. The upper castings of the bearer and of the rear cylinder saddle are riveted to the boiler, the liners being placed outside the shell. The forward equalization divides between the second and third pairs of drivers, thus giving a three-point suspension for the front unit.

The front and rear trucks are in many respects similar in construction, and have interchangeable wheels and axles. The front truck is center bearing and the rear truck side bearing, the bolsters in each case being suspended on heart shaped links. The transverse distance between the inside faces of the truck tires is 53¼ in., while for the driving tires it is respectively 53, 53⅜, 53¼ and 53⅛ in. for the first, second, third and fourth pairs of drivers of each group. Flanged tires are used on all the wheels.

The cab is located sufficiently far back to place all flexible stay-bolts outside, where they are easily accessible. To provide clear vision for the enginemen, the front cab windows are placed in specially designed brass frames which permit the glass to extend the full width of the front panels. Steam piping immediately forward of the cab is placed under the jacket; and this, together with the downward trend of the running boards as they extend forward, and the arrangement of all external fittings, gives the engine crew as clear a vision as can be obtained in a locomotive of this size and type.

These locomotives are equipped with force feed lubricators for the front cylinders, and with flange oilers on the leading drivers of both the front and back units. A drifting valve with handle conveniently located in the cab, and having a 2½ in. pipe connection to the steam valve stand, supplies steam to the cylinders when drifting. The main steam valve stand is placed on the roof sheet in front of the cab, and there is also an auxiliary steam manifold on the left side of the back head connected to the steam valve stand and serving the blower in the smokebox, the oil atomizer, tank heater, oil heater, cab heater, sprinkler, flange lubricator heater and force feed lubricator heater. On the right side of the back head is an air manifold, with valves serving the bell ringer, sanders, cylinder cocks for the front unit and cylinder cocks for the back unit. This manifold also has plugged connections for the fire door, tube cleaner, and the whistle.

The oil burning arrangement has a number of interesting features. The damper controlling the intake of air through the fire pan is automatic in its action, opening by draft and closing by gravity. The fire door is provided with an intake riser through the deck, thus preventing cold air from being drawn into the cab.

The firebox has a brick flash wall in the back, and all firebox seams are protected from the direct action of the fire by steam fire brick.

In order to prevent the exhaust from the air compressors from drawing on the fire when drifting down long grades, the compressors discharge into a separate header, which provides an atmospheric exhaust.

The tender of this locomotive is carried on two Commonwealth cast steel trucks of the six-wheeled equalized type. The frame is a one-piece, commonwealth steel casting. The tender is built with a stoker conveyor trough, in view of possibly changing to coal burning in the future. A pilot is placed at the rear end. With capacity for 16,800 gallons of water and 5,800 gallons of oil, these tenders rank among the largest thus far built.

These locomotives have a height over all of 16 ft. 1 in., and a maximum width of 11 ft. 3 in. The length measured from the face of the engine front bumper to that of the tender rear bumper is 104 ft. 4 in. Further particulars are given in the table of dimensions.

Cylinders (4)	28 in. by 32 in.
Valves, piston diam.	14 in.
Boiler:	
Type	Conical
Diameter	100 in.
Working pressure	210 lb.
Fuel	Oil
Firebox:	
Material	Steel
Staying	Belpaire
Length	144 in.
Width	108 in.
Depth, front	93 in.
Depth, back	75¼ in.
Tubes:	
Diameter	5½ in.—2¼ in.
Number	68—310
Length	24 ft.—24 ft.
Heating Surface:	
Firebox	272 sq. ft.
Combustion chamber	160 sq. ft.
Tubes	6,710 sq. ft.
Total	7,142 sq. ft.
Superheater	1,896 sq. ft.
Grate area	108 sq. ft.
Driving Wheels:	
Diameter, outside	63 in.
Diameter, center	56 in.
Journals, main	12½ in. by 16 in.
Journals, others	11 in. by 14 in.
Engine Truck Wheels:	
Diameter, front	33 in.
Journals	6½ in. by 12 in.
Diameter, back	33 in.
Journals	6½ in. by 12 in.
Wheel Base:	
Driving	43 ft. 7 in.
Rigid	16 ft. 6 in.
Total engine	58 ft. 2 in.
Total engine and tender	96 ft. 3½ in.
Weight in Working Order:	
On driving wheels	532,800 lb.
On truck, front	37,550 lb.
On truck, back	24,590 lb.
Total engine	594,940 lb.
Total engine and tender	916,500 lb.
Tender:	
Wheels, number	12
Wheels, diameter	33 in.
Journals	6½ in. by 12 in.
Tank Capacity:	
Water	16,800 U. S. gal.
Oil	5,800 U. S. gal.
Tractive force	127,500 lb.
Service	Freight

International Railway Fuel Association Reports

Oil Burning Practices on Locomotives—Boiler Feed Water Heaters—How Fuel Economy Can Be Affected

In the issue for June was published a report of the meeting and also abstracts of some of the papers presented at the convention of the International Railway Fuel Association, which was held May 26-29. In this and the following pages are presented abstracts of some of the other important papers presented at the convention.

In 1879 it was demonstrated on the Central Pacific, which was the first unit of the Southern Pacific System Lines, that oil could be used as a locomotive fuel. In that year an oil burner was taken from a marine firebox of a boat in San Francisco Bay, and was applied to an eight-wheel Rhode Island locomotive called the "Young America." From this first application, J. N. Clark, Chief Fuel Supervisor of the Southern Pacific Company, has presented in his paper the Development of Oil Burning Practices on Locomotives, the history of the experiences in burning oil in locomotives and steamships. The following is an abstract of that portion of the paper that deals with the construction of locomotives for burning oil.

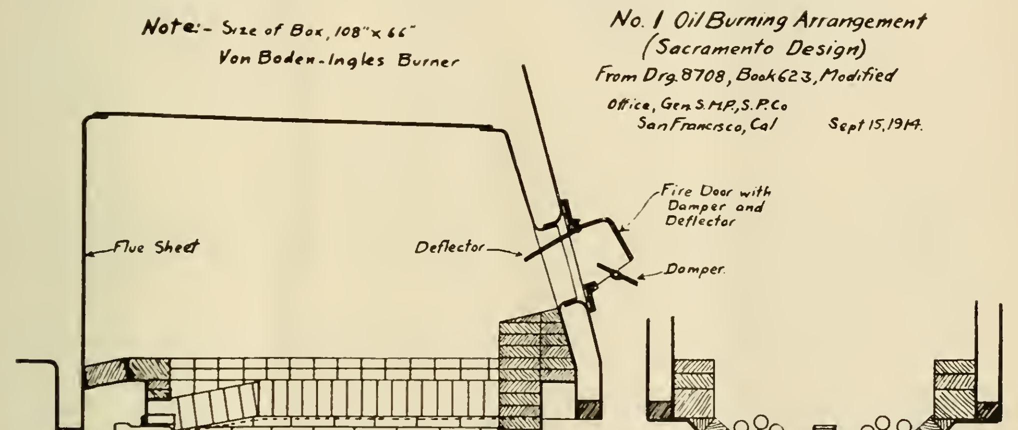


Fig. 1—Oil Burning Arrangement with Horizontal Draft

Burning Oil on Locomotives

By J. N. Clark, Chief Fuel Supervisor, Southern Pacific Company

After various experiments, two standard drafts were adopted, the horizontal Fig. 1, with air openings around burner and through baffler door, and the vertical Fig. 2, with flash-hole or draft opening in front of flash-wall, with solid door and only enough air around burner to keep it cool. With the large fire-box and combustion chamber, success is being had with a combination of the two drafts, using a hooded damper over the opening in front end of pan, a flash-hole in bottom of pan from 9 to 18 inches in front of flash-wall, and a baffler door with maximum air opening of about 4 inches by 16 inches. We corrected a lot of our carbon trouble by moving this flash-hole far enough away from the flash-wall to avoid chilling the refractory below ignition temperature. We try to admit air to fire-box in such a manner that it must cross the path of flame on its way to the flue sheet. With the exception of the small amount of air admitted around the burner to prevent it from being overheated, all other air entering the firebox has but one function and that is to aid combustion. Air, in excess of the amount required for perfect combustion, wastes fuel at the rate of 1 percent for each 10 percent of excess air. Where nozzle is 1/4 of cylinder diameter, air opening into fire-pan is figured on basis of seven times the diameter of cylinder. Another rule in general use is to figure the air opening at approximately 30 per cent of flue openings.

Damper controls of various types have been experimented with since oil burning began. The original damper control, which came up through the deck, necessitating the fireman getting off his seat to operate it has been changed to present method which is under the firing regulator handle and is easily operated from fireman's seat. The damper control that is simplest, most easy of access and most accurate, is the one that should be worked out to fit local conditions, and future developments will no doubt be along the lines of worm gear, which is the standard on French railways and is coming into favor in our larger power houses.

Firing valve regulating flow of oil to burner was originally located under burner and was connected to regulator with a series of rods and pins, but this plan is now changed and the valve placed directly under the regulator so that all lost motion is eliminated. Firing regulator handles, which were formerly of the straight lever type have been displaced with latch and segment, which insures a more positive control.

Firebox Refractories

Very early in our oil burning experiences we learned to have a very high regard for fire-box refractories. Oil is burned in suspension and is a traveling fire. It must have no hindrances put in its path. Anything that does interfere with it becomes a potential engine failure. Our present fire-pan construction makes possible the immediate removal of fallen brick by raking them through flash-hole or draft-hole beneath burner, but we endeavor to prevent brick from falling in flameway by seeing that they are properly placed, with least possible space between them, with a bearing against the metallic surface of pan, so that all air leaks are eliminated around them and that pan does not vibrate nor strike against engine frame.

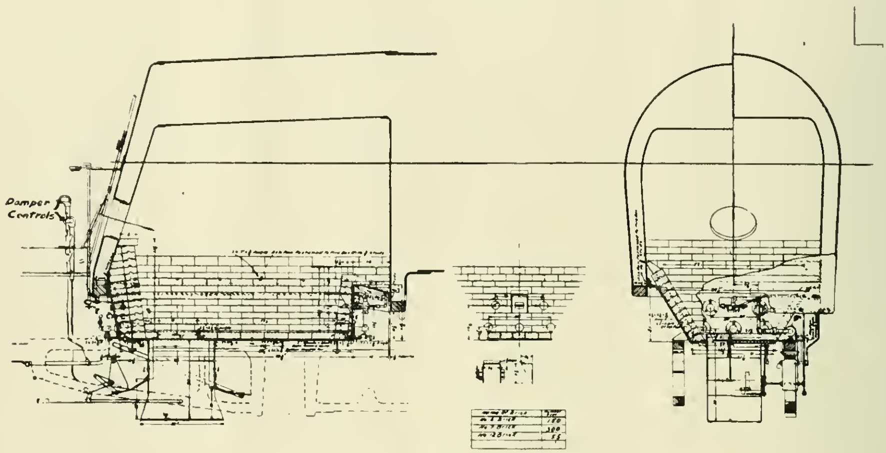


Fig. 2—Oil Burning Arrangement with Vertical Draft

Steam manifold for piping to different operating valves has made a marked improvement.

Two steam gauges and two water glasses are used on each locomotive, so that engineer and fireman have in front of them at all times accurate steam pressure and water level.

The use of superheated steam for atomizing oil is supplanting the former practice of using saturated steam.

Firebox Volume

The first locomotive in which oil fuel was burned had boilers with low ratio of heating surface to cylinder volume. In order to furnish steam it was necessary to force combustion in the limited space. Hot gases were drawn from fire-box because the boiler was forced to such an extent to produce the steam required that much of the heat that should have been absorbed, passed through the tubes to atmosphere.

In later years more attention has been given by designers to provide boilers of ample capacity to provide steam to supply cylinders. It was also found that a large fire-box volume improved oil burning conditions, and the combustion chamber has become quite popular. The combustion chaber in addition to increasing fire-box volume, also increased the flame travel, more heat being transmitted through fire-box sheets and the gases enter the tubes at a somewhat lower temperature. This reduced to considerable extent tube sheet troubles and resulted in lower exhaust gas temperatures in smoke-box. This reduction of temperature and volume of gases has resulted in a reduction of back pressure in cylinders. The first oil burning locomotives had fire-box heating surface only 190 times the cylinder volume; this factor on modern oil burning locomotives has been increased to 290 times the cylinder volume.

It was our former practice to use two rows of brick next to side sheets, placing them to protect the three bottom rows of staybolts. From our experience we have found it preferable not to heat side sheets too hot near mudring in order that space just above mudring will be utilized for the purpose intended, namely, a settling chamber where mud and sludge will accumulate and be washed out, not carried up over crownsheet. Brick applied in this manner also prevents flame from impinging on side sheets, which is beneficial to side sheets and staybolts.

It is our present practice to lay brick on edge 4½ inches high and 9½ inches deep to flame, especially the flash-wall and shelf of pan. These brick are so placed that any vibration or jar will cause them to move toward the metal sheets instead of towards the center of fire-box.

Front End Arrangement

In the earliest installations front end nettings, formerly used on coal burners, were allowed to remain in place and much trouble was experienced in firing up. This was caused by moisture on the netting, which greatly interfered with draft and caused carbon or asphaltum to form.

Stack covers which were in general use then helped to cause this sweating. Except in grain growing districts during harvest time, all nettings are now removed and the use of stack covers has been discontinued.

The rule now generally used is to have the nozzle one-fourth of the cylinder diameter, varying this to suit conditions.

Air leaks must be avoided in front end of smoke-box, around bottom of stack, steam pipes and smoke-box door.

Latest type locomotives received by the Southern Pacific Company have smoke-box throttle placed between superheater header and cylinders. This eliminates the necessity of superheater damper and deflecting plates and provides superheated steam for all auxiliaries, atomizing of oil and blower.

Eliminating Fire Hazard

One other feature of the development of the oil burning practices on locomotives has been to reduce, as much as possible, fire hazard. A review of the records indicates that for the 30 years between 1872 and 1902, during which time wood and coal were the prevailing fuels over the Sierra Nevada Mountains, there was an average annual fire loss of 1,770 feet of snow sheds. With the advent of oil as locomotive fuel, this shed loss dropped to 563 feet per year, and from 1916 to date we have no record of a fire in snow shed territory caused by sparks from a locomotive.

On a line traversing an agricultural or grazing country, fire hazard from locomotives requires very careful supervision, and a record maintained from 1907 to 1917 shows an average of 92 grain fires per year. For the year 1924 there were 35 such fires reported. This improvement has been due, in a large measure, to the study given to drafting and front end arrangement and to the use and maintenance of proper sized netting during the dry season.

Reviewing the development of oil burning practices on locomotives during the past thirty years brings us face to face with many exploded theories, high hopes have been entertained for vast economies and bitter disappointments have been suffered, when, in actual practice, it was proven the idea was unworkable.

Every careful student is willing to admit there is much to be done before we have reached the ultimate in the burning of oil in a locomotive fire-box. In this willingness, coupled with a desire to contribute something of lasting good, lies the hope of future development.

Report on Boiler Feed Water Heaters

The committee is able to report a very substantial gain in the number of feed water heaters applied and on order as of May 1, compared with previous years as follows:

Year	Feed Water Heaters	Exhaust Steam Injectors
1920	7	..
1921	54	..
1922	234	..
1923	1,429	..
1924	2,123	24
1925	2,551	37

This remarkable gain in the past few years is conclusive of the practicability of the feed water heater.

Closed Type Feed Water Heater

Since the last report of this committee, important developments for the closed type feed water heater equipment have been three in number as follows:

1. Development of a duplex feed pump of smaller size, but larger capacity and smoother action compared to the original simplex type.

2. Perfection of means for preventing accumulation of scale in the heater.

3. Protection of the heater equipment against any possible corrosion, electrolysis or action of acid used in washing.

The new type of boiler feed pump developed by the Superheater Company with the Elesco closed type feed water heater is known as the constant flow type. This is of the duplex arrangement wherein steam distribution is so arranged that the movement of the two pistons is the same as if they were connected to cranks set at 90 deg. angles so that with one piston at the end of the stroke, the other is at that instant at mid-stroke, thereby insuring that when one piston is reversing the other is delivering a steady stream of water. Thus a steady regular flow of water is produced, which insures keeping the boiler check off its seat while the pump is in operation.

This pump is capable of discharging 10,000 gallons of water an hour against a pressure of 225 lb. There are now over 300 pumps of this design in service and it has been adopted as standard equipment for the larger sizes of Elesco feed water heaters.

Brief mention was made in the discussion of last year's report to the effect that methods were being developed which would prevent accumulation of scale in the tubes of the closed type feed water heater in bad water districts. It was explained at the time that this process consisted in the addition of a very small amount of a compound to the water in the tender, which acted as a protective colloid and would prevent the precipitation of scale out of the feed water until after it had passed through the heater. The compound for this purpose is chestnut bark extract, a product commonly used by tanners. This is fed into the water in the tender in proportion of one part extract to about 100,000 parts of water. Tests have shown that some anti-foaming compound regularly fed produces the same results.

Experiments have been carried on during the past year in the district where the largest amount of scale accumulated in the tubes of the feed water heaters. It has been found that it is possible to run heaters continuously in that district without cleaning, and without accumulation of any scale or other deposits in the heater tubes. Inasmuch as the most satisfactory results are obtained when the compound is added to the water in the proper proportions a mechanism has been developed which will automatically measure and feed the compound whenever water is taken. It will normally cost about ¼ cent per 1,000 gallons for treating the water in this way, after the apparatus is applied. It is only recommended that the anti-scale treatment be used in cases where the heater requires washing each 30 days or less.

In certain districts some trouble has been encountered from corrosion from acid washing and electrolysis of feed water heaters, due to some unusual condition in the feed water. In order to prevent all troubles of this nature arrangements are now made to cover all steel or iron parts of the Elesco feed water heater that are touched by water, with a non-corrosive coating. It is the intention of the manufacturers to protect all feed water heaters in this way.

Open Type Feed Water Heaters

There have been purchased to date, by the railroads of the North American continent, slightly more than 1,400 open type feed water heaters. Operation of these units has gradually improved through the growing familiarity of the users with the construction and functioning of the apparatus, with the development of organized maintenance and with gradual improvement in materials and construction. The latter have included steps looking to the perfection of the steam valve gear and the water valve service and the selection of suitable materials for gaskets and pump piston and piston rod packings.

The Pennsylvania Railroad has released information concerning tests made on the locomotive testing plant of open type feed water heaters applied to their Decapods or 2-10-0 type locomotives in which they show that within the capacity of the feed water heater they credit a saving of 14 per cent as an average throughout its complete range. This is somewhat higher than has been previously reported by your committee, but this range could well be made with a coal burning locomotive where the coal rate per square foot of grate area is high and sonsequently reduces the boiler efficiency.

Cleaning of the open type heater, where necessary at all, and in all but the most exceptional cases, can be deferred to the general shopping date. Methods of cleaning, thus far resorted to, consist of scraping, washing, and the judicious use of the scale solvents on removable parts. Fully half of the installations thus far made are characterized by the omission of the oil separator from the exhaust steam line to the heater this having been done at the option of the users, thus far, with no results that prompt them to question the correctness of this line of procedure.

Scale formation in the heater is confined mostly to the upper section of the heater, where, between shoppings scale will form to a thickness of between one and two inches. In the lower sections of the heater, the formation of scale is not noticeable. These scale formations in the heater, however, do not affect the working or the temperature of the water delivered. Another troublesome scale formation is found in the atmosphere vent pipe from the heater, which has, at times, been entirely closed by scale and when in this condition it reduces the temperature of the feed water as much as 15 or 20 deg. on account of the inability to get rid of the air in the heater.

Exhaust Steam Injectors

In the 1923 and 1924 reports of this committee, brief mention was made of the exhaust steam injector, and attention was drawn to some of its more prominent characteristics. The development of this apparatus to meet American conditions has progressed steadily during the last three years. The principal attention has been given to the perfection of an automatic control arrangement, making unnecessary the manipulation of a number of levers and valves for the proper operation of the instrument. Many of the older types have now been changed and all new ones furnished are equipped with the new control.

As now arranged the operation of this injector is simple and requires little attention on the part of the engineman. To obtain the most economical results it should be operated by adjusting the water regulator so as to meet the demands with the use of as little supplementary steam as possible. The amount of this supplementary live steam when the locomotive is in operation depends largely on the exhaust steam pressure and the temperature of the feed water. The injector has been known to work perfectly against 200 lb. boiler pressure with the supplementary steam shut off entirely when the back pressure was about 4 lb. and the feed water temperature was 45 deg. F. Injectors will handle feed water successfully up to 85 deg. F. temperature.

It is very important that the size of the injector be suited to the size and power of the locomotive.

Some figures are now available in connection with the cost of maintenance of the exhaust injectors. One road reports that the cost of maintenance for 12 months, from April 1, 1924, to April, 1925, on eleven injectors amounted to a total of $490. Of this amount $265 was for material and $225 for labor. This amounts to about $45 per injector per year, or $1.20 per 1,000 miles. These eleven engines made a total of 407,245 miles during this period.

The following quotations were selected as typical from various reports received by the committee:

"This device has given us about 5½ per cent reduction in water consumption with a proportionate saving in fuel since its installation in July, 1923. It is my opinion that when the mechanical imperfections we have found in the injector have been eliminated, it will show a saving of between 10 and 11 per cent in fuel"—Report dated April 5, 1925.

"Our experiences with this injector have been so satisfactory that we anticipate a considerable extension in the use of this device. Results of road tests made with very meagre test apparatus showed the exhaust steam injector to save about 7 per cent when compared with a non-lifting live steam injector."—Report dated April 10, 1925.

Inasmuch as such test data now available does not point to any definite conclusions the committee hesitates to give a general statement as to the savings which may be expected of the exhaust steam injector. The lack of determinate data can in part be attributed to the number of variable factors involved such as the use of both exhaust and live steam and to variations in efficiency which may occur at the various rates at which the exhaust injector is operated. It is established, however, that there will be a noticeable drop in back pressure and that the superheat will be lowered about 15 deg.

Feed Water Purifier

The Canadian National was experimenting with one locomotive equipped with a feed water purifier placed on top of the boiler so that the discharge from the feed water heater and injectors passed through it to the boiler but so much trouble was experienced that it was removed and within the knowledge of the committee there are at this time none in service in this country. This device is particularly applicable to waters which contain a great amount of carbonates and feel that this is a subject that should not be dropped by the American railways.

Feed Water Heating at Terminals

Last year the committee referred to the fact, that approximately 20 per cent of all locomotive fuel is consumed at terminals, and presented some figures to show the effect on fuel consumption of supplying hot filling water for locomotives, where the filling water is heated by blown off water and steam that would otherwise be wasted. It was estimated that the possible fuel saving from this source amounted to from 1,500 to 2,000 pounds of coal for each locomotive filled.

One of the factors in connection with the savings from boiler feed water heating at terminals is found in the reduction of steam blower consumption, resulting from the reduction in time required for firing up locomotives filled with hot water over the time required to fire up a locomotive filled with cold water. The test which will be described in more detail in subsequent paragraphs indicated that this saving in time amounted to about five minutes in the time required to steam up a locomotive for each 10 deg. increase in the temperature at which the boiler was filled. On this basis, it will require about one hour less to steam up a locomotive filled with water at 180 deg. F. than the time required to steam up a locomotive filled with water at 60 deg. F.

As the saving in blower steam consumption resulting from a reduction in the time required to steam up a locomotive depends upon the rate of steam consumption of the blower itself, the committee further undertook to investigate the situation with respect to the quantity of steam required for blower purposes. It is apparent from the replies received, that this phase of locomotive terminal operation has received very little consideration, and that the quantity of live steam ordinarily required for firing up locomotives represents a greater fuel loss than is generally appreciated. While no general conclusion as to steam consumption required for blower purposes can be drawn from the above, it is evident that the blower is a fuel consumer of sufficient magnitude to warrant careful attention.

In this connection some very interesting information was submitted by the Baltimore & Ohio on the use of a motor driven induced draft fan for steaming up locomotives. The following table shows the results of some tests comparing steam blower operation and an electrically operated fan.

These figures show up the cost of operating a steam jet in a very forceful manner. For practically the same conditions throughout, the fan was able to fire up a locomotive for a cost of about 3.7 per cent of the cost when using the steam blower.

The latest important development in connection with boiler feed water heating at locomotive terminals is the direct injection into the locomotive boiler of live steam together with hot filling water for the purpose of reducing the time and fuel required to steam up locomotives. This method may also be utilized for steaming up locomotives to a working pressure without lighting the fire, for the purpose of eliminating smoke and blower steam in the engine house. In addition to the economy to be gained from filling with hot water, the direct injection of live steam generated in an efficient stationary boiler requires less fuel than the same amount of steam generated in the locomotive firebox during the firing up period. The reduction in blower steam required with this method represents a further fuel saving.

Items	Fan	Steam blower	Difference
Kind of coal used	R.m. gas	R.m. gas	....
Kind of kindling used	Fuel oil	Fuel oil	....
Average temperature of water at start, deg. F.	72	76	4
Pounds of coal on grates at start	1,212	1,206	6
Pounds of coal fired during test	690	681	9
Total coal used, pounds	1,902	1,887	15
Draft in smoke box, average, in.	0.84	0.81	0.03
Kw. hours used	4.03	....	....
Pressure on steam blower line, lb. per sq. in.	....	85.5	....
Pounds steam used per hour	....	2,452	....
Pounds of steam needed to draft locomotive	....	2,800	....
Area of blower nozzle tip, sq. in	....	0.87	....
Time to get 1 lb. per sq. in. steam pressure after light-off, min	43.0	47.0	4.0
Time to get 65 lb. per sq. in. steam pressure after light-off, min	66.5	68.0	1.5
Cost to draft locomotive	$0.062	$1.682	$1.62
Cost per 1,000 pounds of steam	....	0.60	....
Cost of power per kw.-hr	.0154	....	....

Abstract of Data from Tests of Electric Blowers for Firing Up Locomotives. Tests conducted on a Mikado type locomotive.

The equipment required for direct steaming is the same as for blowing off locomotives and for washing and filling locomotives with water heated by the blown-off steam and water, with the addition of a live steam main from the power plant with connections to each filling drop. With these connections the usual procedure would be to attach the blow-off valve to the combined blow-off and filling connection as soon as the locomotive is placed in the engine house. If the boiler is to be washed or water changed, the contents are blown off through this flexible connection. When ready to fill, both the filling and live steam valves are opened. The hot filling water and live steam combine in a booster connection and enter the locomotive boiler at a temperature considerably over 212 deg. As soon as water shows in the glass, the hot water valve is closed and the flow of live steam continued until a working steam pressure is built up in the boiler.

This practice was referred to in the previous report in connection with the subject of feed water heating at terminals and several installations of the direct steaming system are now being made at new terminals so that a study of this method in regular operation will be available for the next report. For the current report, the most comprehensive data on this subject is found in the results of a series of tests on steaming up locomotives that was conducted by the Atchison, Topeka & Santa Fe during the past year at Newton, Kansas.

The following general conclusions may be drawn from these tests:

1.—The consideration of steaming up without fire implies the use of high pressure steam in power plants and consequent changes in order to obtain the desired speed in building up the steam pressure in the boiler, requiring the use of steam pressures of about 200 lb. and stationary plants built accordingly; also a system for filling at 180 deg. F. and above.

2.—A saving of fuel would amount to slightly over one gallon of oil, or its equivalent in coal, for each thousand gallons of boiler feed water used in firing up when heated 10 deg. F. by the utilization of waste heat.

3.—There would be an average saving of time of about 4 to 5 min. for each 10 deg. F. difference of feed water temperature.

4.—A saving of time would result from the combined filling, steaming and firing up processes, of 35 min. as compared with simple firing up with 180 deg. F. initial temperature. There should be a reduction of stand-by losses together with some reduction of smoke nuisance in roundhouses. The latter would, of course, be especially noticeable in case of coal burning locomotives.

How Can a Chief Mechanical Officer Effect Fuel Economy?

By John Purcell, Asst. to Vice-Pres't. Atchison, Topeka & Santa Fe Railway

The cost of fuel has reached a point where it is the greatest item of expense next to wages. The chief mechanical officer is responsible for maintaining the locomotives in an efficient condition at a minimum cost, and with the increased cost of fuel, certain features that have to do with locomotive maintenance effecting fuel economy will require particular attention.

For many years the mechanical officer has maintained his power by doing the work reported by the enginemen and inspectors. Such appurtenances as cylinder packing, valve rings, superheater unit, steam pipe and nozzle stand joints, grates, smoke box air leaks and stopped up flues were not given attention unless the locomotive was reported as not performing properly. The waste of fuel that takes place between the time a locomotive is in first-class condition and the time it is reported not steaming is of considerable consequence. This has resulted in many roads restoring to a monthly inspection of these features in order to reduce the fuel consumption. This inspection and the necessary repairs are usually handled at the time of monthly boiler inspection and, in addition to the fuel saving, this inspection results in describing the number of engine failures and in the locomotives giving better service on the road.

The average life of a locomotive has been approximately 30 years of service, and on some territories the modern locomotive consumes $30,000 worth of fuel per year, or $900,000 worth of fuel in the life of the locomotive. From the trend of fuel costs in previous years, it can be expected that the cost will continue to increase. The chief mechanical officer is confronted with two important problems dealing with fuel conservation, one being to make existing locomotives more efficient, the other to design locomotives which will render efficient service on the territories where the locomotives are to operate.

There is a field for reducing the fuel consumption of existing locomotives by the application of superheaters, feed water heaters, brick arches, increasing steam pressure, improved front end arrangements, elimination of smoke box air leaks, closer fitting grates, and by application of larger tenders which will reduce the number of stops on the road and eliminate taking water at some of the bad water points on the division. These features may be taken care of with a relatively low capital investment and should be given thorough consideration. The useful life of existing locomotives may be prolonged by these additions and betterments, making them useful and efficient units of increased capacity. The service that existing locomotives are to perform in future years should be studied, and where the capital is available, locomotives should be equipped with fuel saving devices of proved merit which will give a net saving for the application. Complications on account of weight distribution on some of the existing locomotives will be found a limiting factor.

The application of devices on new locomotives is less complicated. The locomotives being built each year secure a greater efficiency in the use of fuel. The thermal efficiency of locomotives built in 1900 was approximately five per cent, while locomotives are being built today that have a thermal efficiency of eight per cent. These per cents were secured from test plant results and show increase in efficiency of 60 per cent in 25 years. Definite progress is being made to reduce the fuel consumption of the locomotive, and devolopments may be expected in the future that will further improve its efficiency. Experimental work is being done to reduce fuel consumption by use of water tube type of fire-boxes, steam pressure as high as 350 lb., three-cylinder construction, 50 per cent cut-off and the Diesel locomotive.

Value of Tests

Any fuel saving or capacity increasing device will make the locomotives more complicated and increase the cost of maintenance, which must be offset by an increase in the economic value of the locomotive. The chief mechanical officer is confronted by claims of low maintenance and high fuel saving for different devices that are startling. Many railroads do not have equipment accurately to test out these devices, with the result that reports of tests are being furnished which are not representative of the net saving that can be realized from the different applications. The American Railway Association is investigating the advisability of having a centralized testing plant for securing accurate and unbiased results for the member roads. Such a plan will be of great assistance to roads not provided with test equipment and organization for handling test work, and will have a far reaching effect in reducing fuel consumption.

Proper maintenance and operation are necessary to secure the greatest net saving on investment from fuel saving or labor saving devices on locomotives. The purpose of these devices is to reduce fuel consumption and without proper maintenance and operation this purpose can be entirely defeated and may result in a fuel loss.

The assignment of power suitable for the service to be performed is an important factor in fuel economy, and is equally important in cost of maintaining locomotives. The grades, average speed, character of business both present and future, quantity of fuel and the available boiler feed water must be considered. A thorough study of these conditions and careful methods of arriving at tonnage ratings of new as well as old locomotives is necessary to assign power intelligently to produce a minimum fuel consumption per unit of work.

A uniform quality of fuel should be furnished over the entire territory to which the locomotive is assigned. Tests should be made to determine the relative consumption per unit of work for each different fuel that is available.

Proper Locomotive Utilization Saves Fuel

The utilization of locomotives has been materially increased in the last ten years by the general pooling of power, and in more recent years by extending locomotive runs. It is questionable whether the pooling of power resulted in any fuel saving, but the extended locomotive run over several operating districts, or the quick turn-around on single operating districts without knocking the fire has resulted in fuel saving as well as decrease in maintenance cost. The limiting factors on how far the locomotive can run before requiring roundhouse attention are the design of locomotive, quality of fuel, quality of boiler feed water, character of business and facilities for maintaining the locomotives. It has been found economical and practical to run passenger locomotives from ten to twelve hundred miles without roundhouse attention by having turn-around attention at the end of half of this mileage. Locomotives in through freight service are being operated for distances from three to five hundred miles without roundhouse attention, with an equal measure of economy. This operation eliminates the fuel consumed at intermediate terminals and greatly reduces boiler maintenance costs on account of relieving the boiler of the severe strain caused by expansion and contraction in cooling down and firing up.

While the chief mechanical officer can assist materially in the conservation of fuel by keeping his locomotives in first class condition, the enginemen and firemen can also assist very materially in reducing fuel consumption. I had an opportunity sometime ago to review the performance of 18 passenger locomotives of the same type and size, running in pool service and handling the different trains on a 200-mile division. The report shows the performance of each individual engineman and fireman, as well as each locomotive. The amount of fuel consumed varied, on the same locomotive and same train making the same number of stops, under the same weather conditions, as much as 15 per cent. The best performance was accomplished by the proper operation of the throttle and reverse lever; also lubrication, good firing practices, avoiding waste of steam through pops, and the height the water was carried in the boiler.

It is possible for the best maintained locomotive and the best trained engine crew to show a poor fuel performance if the train is not moved at an economical speed, or if the train furnished by the transportation department does not utilize the capacity of the locomotive. These transportation features are as important in fuel conservation as the design, maintenance, assignment or efficient operation of locomotives, which are the direct duties of the mechanical officer.

New Pacific Type Locomotives of the Reading Company

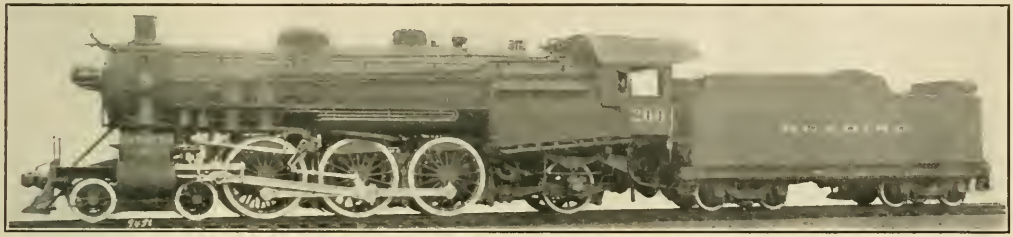
The Reading Company has recently placed in service five new Pacific type locomotives built to its specifications by the Baldwin Locomotive Works

The Reading Company has recently placed in service five new Pacific type passenger locomotives constructed by the Baldwin Locomotive Works to designs and specifications provided by the railroad. The engines have 25 in. by 27 in. cylinders, 12 in. diameter piston valves, and 74 in. diameter driving wheels. The engine truck wheels are 36 inches in diameter and the trailer truck is equipped with 54 in. wheels. The engines have a driving wheel base of 13 ft. 10. in., and the total wheel base of the engine is 35 ft. 9 in.

tion. The front section, which is in the form of a slab 5 in. thick and 13 in. deep, fits between the saddle and the cylinder.

The tender frame is built up with 10 in. and 12 in. longitudinal channels and steel plate bumpers. The tank capacity has been increased from 8,000 to 9,000 gallons. The trucks are of the equalized pedestal type with forged steel wheels.

The locomotives have a width of 10 ft. 5 in. and a height of 15 ft.



Pacific or 4-6-2 Type Locomotive of the Reading Company—Built by Baldwin Locomotive Works

These new locomotives which have the class designation G 1-sb, and the road numbers 200 to 204, are a direct development of Class G 1-sa, twenty-five of which have been built at the Reading shops and five at Baldwin's, and have many details in common with the latter engines. The increase in total weight is about 5½ per cent and in tractive force about 8 per cent. The latter increase is due to the use of 74 in. drivers in place of the 80 in. used on all previous engines of this type.

Flanged tires are used on all wheels and are spaced transversely to allow engine to pass curves of 16 deg.

The boiler, which is the same as previous engines, is of the Wooten type in three courses, the front course having an outside diameter of 72 in. and the rear 80 in. Center line is 9 ft. 9 in. above the rail. The firebox has a combustion chamber 48 in. long with a brick wall 24 in. high. The ash pan has a single hopper of large capacity with a steam blower pipe for cleaning. A special feature is the "Economy" front end smoke box arrangement and the flange oiler patented by I. A. Seiders, Superintendent of Motive Power and Rolling Equipment of the Reading.

All of the locomotives are equipped with the Sellers exhaust steam injector.

The cylinders are cast separate from the saddle and can be applied without disturbing the smoke box connection to saddle.

The valves, 12 in. in diameter, are set with a 7 in. travel, 1⅜ in. lap, 5/16 in. lead. They are operated by Walschaert gear controlled by Ragonnet power reverse mechanism. The rods and motion work are of vanadium normalized steel. Lubrication is supplied to the cylinders by Madison-Kipp force feed lubricators mounted on the back steam chest cover.

Fifty per cent of the reciprocating weight is balanced in these engines.

The main frames are cast in one piece and with the large transverse braces are of most substantial construc-

Details of the locomotives are given in the accompanying table of weights and dimensions.

PRINCIPAL WEIGHTS AND DIMENSIONS

Cylinders	25 in. by 28 in.
Valves, piston, diam.	12 in.
Boiler:	
Type	Conical
Diameter	72 in.
Steam pressure, pounds	220
Fuel	Hard Coal
Firebox:	
Type	Wide Radial Stayed
Length	126¼ in.
Width	108¼ in.
Grate area	95 sq. ft.
Tubes and flues:	
Tubes, number and diam.	163 2¼-in.
Flues, number and diam.	30 5½-in.
Length	19 ft.
Heating surface:	
Firebox	214 sq. ft.
Combustion chamber	78 sq. ft.
Tubes and flues	2633 sq. ft.
Total	2925 sq. ft.
Superheating	675 sq. ft.
Wheels:	
Driving, diam.	74-in.
Engine truck, diam.	36-in.
Trailing truck, diam.	54-in.
Wheel base:	
Driving	13 ft. 10 in.
Rigid	13 ft. 10 in.
Total engine	35 ft. 9 in.
Total engine and tender	71 ft. 10¾ in.
Weight in working order:	
On driving wheels	177,210 lbs.
On engine truck	51,170 lbs.
On trailing truck	59,740 lbs.
Total engine	288,120 lbs.
Total engine and tender	471,600 lbs.
Rated tractive force	44,200 lbs.
Tender:	
Capacity, coal, tons	15
Capacity, water, gallons	9,000

Railway and Locomotive Engineering

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The Railroads and Repairs

It is only a short time ago that the railroads thought that they had solved, in part at least, the question of the high cost of repairs. They found that there were plenty of men and plenty of firms who could and would underbid their own shops in the cost of repairs. And the officers being of a thrifty turn of mind made contracts with sundry and anon to do this work, complacently conscious that they were doing a wise and prudent thing for their own reputations and one even more wise and prudent for the stockholders of the property of which they had charge.

But the railroads must not save or manage well if the results of that saving and management is to act to the diversion of work from their real managers, the unions, however much it may redound to the benefit of such insignificants as the stockholders and the general public. So there was a hue and cry that the railroads were unfair, and that they were not living up to the requirements that have been put upon them, namely, that they shall buy in the dearest market, especially if what they buy is labor. So they were enjoined and forbidden to do this thing and make this saving, and like good little boys caught in a net and tied hand and foot they acquiesced.

But those capitalistic concerns who had tasted the blood of the nearly bloodless are reluctant to give up a prey that was so willingly theirs, and have come to the front demanding that the railroads show cause as to why the contracts were cancelled. As though the little innocents did not know the cause, bless their dear little hearts.

So they have come a mighty phalanx and demanded of the Interstate Commerce Commission that the railways shall so change their method of accounting that the true cost of car repairing shall be given; maintaining that, if this were to be done such accounts would show that the costs in the companies' shops were greater than that of the contract shops. And there were seventeen of these contracting shops represented. They assert that the full significance of the order was not appreciated at the time of its promulgation else they would have presented their protest at the time.

They protest that the proper function of a railroad is to furnish transportation and not to compete in manufacturing; that the railroads cannot and do not show proper costs; that the decision of the commission that the railroad in its estimates of cost should disregard overheads, is without justification in fact or theory; that it is doubtful whether the commission really had jurisdiction in the matter, and even if some extravagant contracts were made, it does not justify the condemnation of the system; that no conclusion applicable to the car industry as a whole should be drawn from an isolated instance; that comparisons cannot be made without paying due regard to inspection, and that that to which a manufacturer is subjected is quite different from the total lack of it in the railroad shops; that speed of delivery should be taken into account; that the adjudging of labor problems and disputes does not fall within the province of the commission; that to force the railroads to provide facilities to care for peak requirements would unbalance their labor conditions, and that the entrance of a public service corporation into the field of private industry is uneconomical and un-American.

So here we have a pretty how-de-do. The politicians throwing mud and accusing the railroads of everything on the calendar and wastefulness in management is not the least of the alleged crimes; the car contracting establishments siding with them so far as the assertion of the commission of the crime is concerned, but placing the responsibility on the commission where it probably does not belong, and quite disregarding that—well call Congress what you will—by whom the commission of the crime was forced.

The officials would like to show true costs and cut them down in any legitimate manner, but it is doubtful if they will be allowed. There are other powers more powerful than the Interstate Commerce Commission that will have to be consulted before any cutting of costs will be allowed, and, after such consultation, it is a safe guess to say that things will remain about as they are, unless they get worse.

The Automatic Stop and the Prevention of Accidents

Few people have much respect for the wisdom of Congress, and in view of the legislation of recent years just past, and the final influence which is said to have influenced the vote, the disrespect not to say the disrespect verging on contempt in which that body is held would seem to be pretty well justified.

There have been some bitter criticisms made, for example on the law and the ruling of the Interstate Commerce Commission, as a result of which the railroads are called upon to spend tens of millions of dollars in installing automatic stops, while other necessary improvements go begging.

It is contended that the automatic stop is useful in averting one kind of accident only and that is a collision, and yet collisions are the cause of far fewer casualities and fatalities than derailments. For example, four times as many people were killed in one recent derailment as in all of the collisions in the United States in a year. The grade crossing, in combination with the reckless automobile driver, is responsible for many times the accidents that collisions are. The only compensation for which is that for every such fatality one more menace to the public has been removed. Yet the automatic stop is useless in this connection.

Derailments are the main thing to be guarded against, and the causes of their occurrence are manifold, but for not a single one of them is the automatic stop an antidote. There are brakes and wheels and rails and soft spots and washouts, all thronging in to contribute their quota to mishaps, but not one influenced in the slightest by the automatic stop.

Not but that the automatic stop is an excellent thing in itself and deserving of all attention and respect, but the question is whether the money called for, for its installation might not be better employed in other directions.

If the railroads had unlimited funds, as some of our Congressmen seem to think, it might be well enough to order them to install the automatic stop, as well as many other things. But with affairs as they are, and the railroads put to it to raise the money for crying demands it seems a little tough to insist upon this expenditure that will probably not produce the maximum benefit that such an expenditure, made in other directions, might be expected to insure. However, in the language of the infamous Tweed, "What are you going to do about it?"

The Steam Engine

There is probably no branch of engineering in which greater strides have been made than in the development of the steam engine as a prime mover. Its value and influence upon the development of a higher order of civilization would be difficult to estimate.

During the period of the wonderful progress made in steam engineering, and more particularly in the last 30 years there has been repeated efforts to discredit the steam engine, some even going as far as to make preliminary arrangements for its "Last Sad Rites."

To those however who have aided in its development, and look for still greater things in the way of increased economies resulting from a still higher degree of refinement in design and operation, it is refreshing to know that among our English cousins there is a tendency to accord the steam engines its proper status in the engineering world.

Those engineers who, for more or less sentimental reasons, have deplored the supersession of the steam engine by the internal-combustion engine, may take heart at the forecast of Dr. John S. Haldane, president of the Institution of Mining Engineers. At the annual meeting of the Institute, which was held in Cardiff, Wales, on June 16, both Dr. Haldane and Sir John Cadman suggested that the present extensive use of oil fuel was only a passing stage, and that coal would reconquer many of the fields of utility which have been invaded by oil. As regards the relative merits of steam and oil engines, Dr. Haldane said that he believed steam engines would, in the not very remote future, take the place of internal-combustion engines in many cases where internal-combustion engines are now employed. In a steam engine, he said, jackets were used to conserve heat in the cylinders, but in an oil engine it was necessary to waste heat to keep the metal of the cylinders at a safe working temperature. The future development of the steam engine would be along the lines of higher pressures, with smaller boilers and lighter engines, so that in all probability they would be more suitable than petrol engines for aeroplanes and motor cars. He did not think that steam engines and internal-combustion engines would ever fight, but believed that the steam engine would beat its competitor.

Railway & Locomotive Engineering fully recognizes the wonderful engineering field which is open to the application of electricity and the internal-combustion engine, this does not mean however, that the steam engine is approaching retirement or has even reached the peak of its fame.

With a supply of coal in nature's store house, available for the use of man, estimated at from 540 years to as high as 2,000 years, there is little cause to feel apprehensive as to the retirement of the steam engine but we may well look forward to still greater development in design and its application as a prime mover.

The 4-6-2 or Pacific Type Locomotive

To the Editor:

The writer was very much interested indeed upon reading in the June issue of the Railway and Locomotive Engineering Magazine, the article by W. E. Symons, on the early history of the 4-6-2 or Pacific Type Locomotives, and the writer of this article apparently is quite familiar with the history and facts as regards the three locomotives to which he referred.

This article was of particular interest to the writer from several angles; the foremost of which was from the fact that my father, S. A. Stephens, who at that time was the Sales Manager of the Rhode Island Locomotive Works, was in no small measure responsible for the conception of these engines, and worked out the details with the late J. N. Barr, who at that period, was S. M. P. of the C. M. & St. P. R. R. I was at that time employed as a machinist in the works of the Rhode Island Plant and helped in the erection of the engines in question, and later had charge of the company's exhibition at the World's Fair in 1893, where one of these engines, No. 830, was exhibited, and where it attracted a very great deal of attention. The remaining two engines were put in service during the Summer of that year on the Milwaukee Road, but it soon developed that they would not be a success as compound locomotives, as they were originally built, of the Batcheldor two cylinder cross compound type, with intercepting valves. As they experienced at the time, and before the change was made, a great deal of difficulty in getting these engines to properly steam, due I think in no small degree to the fact that the number of exhausts with the two cylinder type of compound being reduced just one-half, and at that, the exhaust was very low, although varying sizes and types of exhaust nozzles were tried out, it was found by reducing them to a point where the fires could be properly worked, that an excessive back pressure was set up which caused considerable trouble.

The writer had the opportunity of seeing these engines in service some years later on the Atlantic Coast Line, but I must say that I would hardly have recognized them from my recollections of what they originally were built.

The writer read with a great deal of interest, the article published about a year or more ago in the Baldwin Quarterly Magazine, that dealt at some length with the 4-6-2 locomotives, which that company built for the New Zealand Government Railways and which were designated as Pacific type. Of course, at the time the Rhode Island engines were conceived, no practice had been adapted designating particular names to various types of locomotives according to the wheel arrangements as is in vogue today.

New York, N. Y. Thos. P. Stephens.

The author of the article to which Mr. Stephens refers was quite familiar with the history of the locomotives.

About the time that the three engines were returned to the Rhode Island Locomotive Works by the Chicago, Milwaukee & St. Paul Railway, the panic of 1893 and 94 was well under way. Banks were closing their doors and railways in great number were being forced into receiverships. Many industrial concerns, including the Rhode Island Locomotive Works, were thrown into bankruptcy. The three locomotives referred to stood idle at the Providence plant until the International Power Company reopened the plant in the late nineties.

After standing several years in a rather frail structure that did not afford full protection from the elements the three returned locomotives did not look any too inviting as motive power investment, but, as stated in the article, the Plant System was badly in need of power and in fact were in the market for new locomotives. The International Power Company had not only been asked to bid on 25 new ten-wheeled engines, but to name a price on those engines which the St. Paul Railway had returned some 5 or 6 years before.

Mr. S. A. Stephens executed a contract with the writer of the article for 12, ten-wheel engines to be built at Rhode Island, and arranged the sale of the three returned engines at a price about 30 per cent less than the cost to build them. This included that they be put in first class condition as single expansion 4-6-2 type engines, and delivered at Savannah, Ga., where they gave very good service. Mr. Stephens is correct as to the part his father took in the original design of these engines, and no doubt there are many who are surprised to know the history of these locomotives that were so admired in Chicago at the exposition in 1893, were rejected and then came back, and now 33 years after construction for the Chicago, Milwaukee & St. Paul Railway are in service on a trunk line railroad in Florida.

The physical life of a locomotive depends on a number of factors, principal among which is the standard of maintenance. With certain betterments and renewals, any particular locomotive may be perpetuated, as it were, for an indefinite period. The present ten-wheel type locomotives referred to and now in service on the Atlantic Coast Line Railway 33 years after their construction for the Chicago Milwaukee & St. Paul Railway being a striking example. ED.

Working Capital Versus Idle Money or Frozen Accounts

It requires working capital to run any kind of business no matter whether it be a peanut stand on the street corner, a railway system or the United States Government, for aside from and in addition to the actual investment in the physical property itself there must be at all times available for use material, supplies and ready cash with which to transact business. If any one doubts this, just let them attempt to run either a peanut stand or a railroad. Our railways now have an estimated value of more than $22,000,000,000 while the millions of money actually ploughed back into the properties each year is increasing their real value.

Large items in the balance sheet of our railways are materials, supplies and cash.

In 1913 these items amounted to $694,890,485, or about .0347 per cent of the total assets.

In 1923 or ten years later these items amounted to $1,122,205,644 or about .051 per cent of the total assets, the increased amount in dollars being about $427,315,159. No one with the slightest knowledge of railway matters will question the necessity of material supplies and cash in order to operate a railway, and it will also be admitted that much of the material and supply account is turned over several times during the year and that the cash or money is kept pretty well in circulation. Therefore, from reports and from conversations with those in authority one might decide that operation could not be safely handled with any less of the three items. As a matetr of fact, some of those most liberally supplied actually think and do not hesitate to say that they should increase their stocks of both raw and finished material, and supplies.

Some years ago railway men were somewhat startled by the announcement of a prominent lawyer that if the railways would practice economy in operation they could save one million dollars a day. He did not however, provide a good, clear practicable method or formulæ for effecting this great saving. Other experts, efficiency engineers, specialists, and just common railway doctors have come forth from time to time as a modern Moses to lead the railways out of Egypt, as it were, to the promised land of prosperity and increased dividends.

A careful analysis of many of these modern Sir Galahad's propositions however, reveal the fact that the only absolutely sure feature of their plan is the amount of direct expense the experiment will cost the company, to which may be added the increased expenses occasioned by carrying out recommendations, changes, etc., that often result in a substantial increase in material and supply account that is already too high and should be reduced instead of increased.

There are, of course, exceptions in which the special agent can be of real value to a railway company and on many of them he could easily effect economies and increase efficiency in a proportion closely approaching the figure set by our legal critic for the whole country some years ago.

Most administrative and supervising officers of railways who have to do with the purchase or use of material and supplies know, or at least should know, about what the turn over is in the various materials used and with this knowledge, together with the distance from source of supply or market, it is not difficult to so order as to not have the company's money tied up in material and supplies for months and years, some of which is never used for the purpose it was purchased and is eventually sold for scrap, or a total loss when of a perishable character.

Just for illustration of potentialities let us take one or two hypothetical cases and then cite actual facts. We will assume a large trunk line system has at the close of business at the end of the fiscal year, material and supplies to the amount of $20,000,000. If this were reduced to $18,000,000 the company would either have $2,000,000 more available cash or would save the interest charge on that amount of capital which at 5 per cent would amount to $100,000 per year, while on a smaller system with say $8,000,000 or $10,000,000 so invested the amount of saving possible would be about half the amount of $40,000 to $50,000 per year, plus certain related economies that would follow a good house cleaning, and a general overhauling of the machinery that is responsible for this excess and in most cases unnecessary investment of company funds.

A certain railway in the middle west gradually ran down until it was finally forced to seek the protection of the court, and receivers were appointed. The owners then employed special talent to investigate and advise them as to the cause of their troubles, apply remedies, and suggest plans for the future. A conference was called of all heads of departments, and with one accord they all declared the principal trouble was no material or supplies to maintain or repair the physical property, particularly cars and locomotives, and as proof of their contention exhibited a great mass of requisitions approved and waiting approval, with telegrams and letters galore urging shipment.

It was also pointed out that the lack of material was holding up the repairs of both locomotives and cars then in shops, that if out and in service would add greatly to the company's income and that bad track conditions were also due to the same lack of material or supplies.

After about every executive and administrative officer down to foremen had definitely committed themselves to the foregoing in writing, so that it was impossible for them to back out and try to change their stories, and before ordering any more material, the special agents went through the whole thing from *"stem to gudgeon"* and here is some, yes, just a few of the things that were found to exist on a railroad that was top heavy with officers, most of whom were seeking an increase of salary while the company's business with which they were charged was suffering badly from acts of omission and commission on their part.

On two divisions, track was in poor condition on account of lack of cross ties and requisitions were in for many thousands of new ones, while on another district there were more cross ties than were needed and some 60 per cent of these had been piled up there from one to two years. The company's money was invested in them but was lying idle while there was slow orders of train speeds on other sections of the road. The same was to some extent also true with respect to bridge timber; slow orders over weak bridges on one part of the line with a surplus of bridge timber or timber unsuited for use at other points, but with the same net result; money tied up in material, requisition for more and little or nothing being done in the way of systematic, methodical maintenance although money enough had been spent to have the track in first class condition.

In the matter of equipment the situation was just as aggravated. A modern passenger engine had collided head on with a modern freight engine the resulting damage requiring new cylinders for each. These engines although badly needed on the road had been standing idle in the shops 6 or 8 weeks awaiting new cylinders from the builders, while in a small addition to the store room, nicely white leaded and waiting for the Angel Gabriel to blow his horn were 6 or 8 sets of locomotive cylinders bought from the builders and paid for years before. These would in all probability never be used as they were for old almost obsolete engines then on branch lines were collisions, *except with a cow,* were almost unheard of, while there was not in stock an extra set of cylinders for a modern engine. Net result, not only a frozen account, or idle money tied up in material, 80 per cent of which would never be used. The company's business was suffering when if one half the amount so tied up had been properly invested in a live or active account the loss would have been prevented.

The shops were full of passenger and freight equipment much of it being held for certain specific sizes of timber or lumber while it was found there were many thousands of dollars worth of lumber in stock, some of it requiring slight alteration in size which could be done in the mill at slight expense, and great quantities of this stock had been on hand so many years that some of it had to be scrapped. Net result as before; the company's expenditures by its officers had been far in excess of the amount necessary to have their equipment in first class condition, yet it was not only in very bad shape, but an unusually large percentage of it was out of commission for repairs. Those in authority were clamoring for new material while with few exceptions there was not only on hand more than ample, but great quantities of obsolete or defective material, supplies, castings, lumber, etc., that had been purchased on requisitions, that never was needed, and eventually found its way into scrap.

In this case, which we will say is an exceptional one, about 50 per cent of the requisitions for new material and supplies which was being so loudly clamored for was cancelled and such material and supplies as had not died or become entirely obsolete from old age was at once put to work. There was a good old-fashioned *house cleaning,* a dead or frozen account was well liquidated, and systematic or methodical plan of purchases was adopted, which was calculated to and did prevent the investment of a dollar of the company's funds in any way that was liable to become dead stock or idle money. Neither was anything bought for any person or any department as long as there was such material in stock.

The present investment of our railways in material and supplies plus cash is approximately $1,122,205,644.00. Of the above amount the material and supply account alone is about $433,459,736.00. Just how much of this, or how many millions is in unnecessary or obsolete material that has been on hands from 3 to 5, and some of it 10 years or more and much of which will eventually find its way into scrap it would not be safe to estimate with any degree of accuracy. That it would easily run into millions is not a wild guess by any means, and that there is scarcely a line of any importance that would not wonderfully profit by a little house cleaning in this important matter of idle money or frozen accounts is a safe prediction for any student of these problems.

Railway Tool Foremen's Convention

The American Railway Tool Foremen's Association will hold its Thirteenth Annual Convention at the Hotel Sherman, Chicago, September 2nd, 3rd and 4th, 1925.

This association is composed of machine shop and tool foremen who have adopted for their motto "Higher Efficiency in the Railway Tool Service." The president of the Association is Chas. Helm, C. M. & St. P. Ry, and the secretary is G. G. Macina, C. M. & St. P. Ry.

Quite an unusual and interesting program has been arranged, which should prove of great value to the foreman attending.

Papers have been prepared by various committees on the following topics, which should bring forth considerable discussion and help to promote efficiency and economy in the tool service.

"Standardization of tools in the Locomotive and Car Shops."

"Grinding in the Railroad Shops."

"Jigs and devices for the Locomotive and Car Shops."

"Forging machine dies."

"Machine tool equipment for the tool rooms."

"Economies possible by Standardized small Tools."

In addition to the above, exhibits of modern machine and hand tools will be displayed through the courtesy of the Railway Supply Association of which C. O. Montague is President and H. K. Clark is secretary-treasurer. All firms desiring space for exhibits should secure details from Mr. Clark, 51 West Water St., Milwaukee, Wisconsin.

Staten Island Railway Electrification Completed

By C. A. Butcher, General Engineer, Westinghouse Electric & Manufacturing Company

The Staten Island Rapid Transit Railway Company, a subsidiary of the Baltimore and Ohio Railroad, operates lines extending from St. George to Tottenville along the south shore of Staten Island in Borough of Richmond, New York City, with a short branch from Clifton Junction to the residential and summer resort section at South Beach. The line to Tottenville, known as the Perth Amboy Division, which is 14 miles in length, serves principally residential sections beyond Clifton Junction. Between St. George Terminal and Clifton Junction the principal business section of St. George is served.

Ferry service is operated across the river between Tottenville and Perth Amboy, New Jersey. The East Shore line operating between St. George and South Beach, a distance of approximately 4 miles serves in addition to its normal residential traffic, a heavy summer season resort traffic. The N. Y. Municipal Ferry operates between the Battery in lower Manhattan and St. George, and also between St. George and 39th St., Brooklyn. A line on the north side of the Island known as the North Shore Division handles mostly industrial traffic. Service on these lines has been operated by means of light steam trains made up of from two to six coaches.

To carry out part of the plan to electrify all railway service in the City of New York, the East Shore and Perth Amboy Division have been electrified for operation on 600 volts direct current. The arrangement provides for an over-running third-rail system, such as is used in the subway and on the elevated systems. Trains are of the multiple-unit type similar to those in subway service.

Electric energy for the system will be supplied from five substations with an aggregate capacity of 10,000 kilowatts located as follows:—

Location	*No. of Converting Units*	*Capacity*
St. George ..	3—1,000 kw. synchronous converters.....	3,000 kw.
South Beach .	2—1,000 kw. synchronous converters.....	2,000 kw.
Old Town	2—1,000 kw. synchronous converters.....	2,000 kw.
Eltingville	2—1,000 kw. synchronous converters.....	2,000 kw.
Atlantic	1—1,000 kw. synchronous converters. ..	1,000 kw.

Each of these substations, with the exception of the one at St. George, will be automatically operated, while the St. George sub-station will be equipped for semi-automatic operation.

A complete system of supervisory control, centralized in the Traffic Operator's office at St. George, places the control of the entire power system in the hands of the Traffic Operator, located at St. George, who will be continuously and automatically advised of the status of the power system.

Primary power at 33,000 volts, 3 phase, 60 cycles will be purchased and supplied over two circuits to each substation from the new Livingston Power Plant of the Staten Island Edison Corporation.

Location and Capacity of Substations

In order to determine the proper locations of substations and the capacity of each, train sheets were prepared, showing graphically the operation of all trains according to the present and estimated future schedules. Based on the number of units per train, weight per unit, schedule speeds, etc., the momentary energy required for starting and the energy required at free running of the trains, composed of from four to six units were calculated.

Following this, detail loads were calculated for each mile of track for each minute during the peak load or period of heaviest traffic. From this, detailed load curves of each mile of track were plotted. Since the capacity of each substation must be based on maximum power requirements, only the period of maximum demand was in this manner analyzed.

An economic study was made to determine the load losses in the distribution system, based on a number of different substation spacings. The arrangement best suited to the present and future developments was determined to be that already given.

In order to check the calculations made to determine average voltage conditions incident to normal and peak load conditions, and to check the distribution of load to the substations, the complete system was set up on a mimic network in which proportional loads, voltages and resistance values were used. From this setup, it was also determined that the 1,000 kw., shunt-wound synchronous converter was best suited for this application.

In supplying power to the mimic network at those points representing the substation locations, the inherent voltage drooping characteristic of the shunt-wound converter, supplied from power transformers having 8 per cent inherent impedance, was assimilated by a series resistor. Under various schemes of loading, based on locations of trains at different times during the peak load, and average load conditions, the voltage at trains and substations loads were determined. It was also determined that the operation of the system is protected against the failure of any converting unit in any of the five substations. A test showed that a concentrated load equivalent to 300 per cent rating of the units in operation in either Old Town or Eltingville substation, when placed at a point directly in front of the substation, would receive 80 per cent of its energy from that substation and 20 per cent from the adjacent stations, dividing 10 per cent to the station on each side. This shifting of load is effected by the drooping voltage characteristic of the equipment only. Similar tests showed conditions of operation incident to various assumed combinations of substations and train operations.

New Signaling System

The old train signaling system which was unsuited for operation on the electrified system, has been replaced by a complete automatic block signaling system which receives energy for its operation from 2,300-volt, single-phase, 60-cycle lines. Located at four substations, are transformer banks stepping down the 33,000 volt supply to 2,300 volts. Arrangements have been made so that each of a number of sections of the signalling system may be supplied normally from but one source. However, in the event of failure of the normal source of supply, such section may readily be transferred to another circuit, thus preventing failure of the signals involved. The supervisory control system also places the control of the power supply to the block signal system in the hands of the Traffic Operator at St. George.

In order to meet a normal increase in demand for electric power, and to provide sufficient generating capacity for the operation of the railway system, the Staten Island Edison Corporation has remodeled and greatly enlarged the generating station at Livingston. The new equipment provides a complete new boiler plant from stokers to stack and a new 18,750 kv.-a., 13,800 volt, 3-phase, 60-

cycle, turbine generator with auxiliaries operating form a 2,300-volt, 3-phase bus. Existing generating equipment generates, for the most part at 660 volts with some smaller part at 2,300 volts.

In supplying power at 33,000 volts, two new three-phase, OISC outdoor type transformers have been provided. One of these transformers is connected to the 6600-volt station bus and the other is connected directly to the new 18,750 kv-a., 13,800 volt generator. These two transformers are connected to a new 33,000 volt double bus system of the outdoor type, through outdoor type 0-331 oil circuit-breakers. These transformers are delta connected on the low side and star connected with grounded neutral on the high-voltage windings. The present lines, three in number, leave the 33,000 volt bus through type 0-331 breakers. A two-circuit line runs overhead across the Island to the Eltingeville substation, the third is an underground circuit to the St. George substation.

One of the most interesting features of the new power station is the switching equipment. All oil circuit-breakers of the indoor type including those for both the 6,600-volt and 2,300-volt circuits are steel-clad, truck-type, factory built and completely assembled before shipment. The entire switchboard is made up of all steel, single section panels. The switching and switchboard equipment were supplied by the Westinghouse Electric & Manufacturing Company.

Substation equipment of both the Railway Company and the Power Company has been installed at the St. George and Eltingville locations. At Clifton Junction, the Power Company has erected an outdoor 33,000-volt, double bus structure from which one circuit runs underground to St. George. Two circuits run overhead, effecting a parallel radial supply to the South Beach substation. A fourth circuit overhead from this station loops through the Old Town substation of the Railway Company and connects to the bus at Eltingville, thus completing a loop which includes St. George, Clifton Junction, Old Town and Eltingville. A double overhead circuit extends from Eltingville to the Atlantic substation. All oil circuit-breakers used on the 33,000-volt system are Westinghouse type 0-331 and type 0-221. Each bus is protected by Westinghouse type "SV" auto-valve lightning arresters.

The St. George Substation

The St. George substation building houses, the substation equipment of both the power and Railway Companies. Located in the terminal yards at St. George and in a position which brings the roof of the building almost on the street level at the junction of a viaduct over the terminal tracks and an adjacent street, semi-outdoor construction for accommodation of the 33,000-volt switching equipment was resorted to in order to prevent exposure of the high-voltage equipment to the public thoroughfare.

The portion of the Power Company's substation equipment which is indoors includes iron-clad, truck-type switching for a 2300-volt, 3-phase, double bus system for local distribution of light and power. Located in this station is also the supervisory equipment for the operation of the 33,000-volt switching equipment at the Clifton Junction station.

Exterior of St. George Substation

Through wall bushings, the 33,000-volt bus in the Railway Company's portion of the structure is connected to that of the Power Company.

The portion of the building occupied by the Railway Company provides space for four synchronous converters together with necessary transformers and switching equipment. Three 1,000 kw., 600-volt, shunt-wound, 60-cycle converters with auxiliary equipment comprise the present installation. However, the space available will accommodate converters of at least double that rating.

Separated by a wall from the machine room, the transformers which are of the OISC outdoor, 3-phase type and the high tension switching equipment which includes type O-331 outdoor type oil circuit breakers, are installed in a structure, open to the weather on three sides. These openings are normally screened by grill work which may be removed to permit the removal of the transformers which are truck mounted. A railroad siding which extends to this side of the building, running between the building wall and the retaining wall below the adjoining street, facilitates the installation or removal of transformers.

Through conduit layed under the concrete floor, the secondary leads from the transformers run to the rings of the converters, and to the manually operated starting switches mounted on panels adjacent to and facing each machine. On the starting panel is also mounted the converter shunt field control switch, a polarity indicator and a control switch for the high tension oil circuit-breaker.

With the exception of the manual starting equipment, the remainder of the switching equipment, which is mounted on panels installed on the opposite side of the machine room, is automatic in its operation and duplicate of that installed in the automatic substations at South Beach, Old Town, Eltingville and Atlantic. This equipment is described in the following pages.

Five 2,000 ampere, automatic service restoring panels supply the feeder circuits to the third-rail system in the yards and to the tracks leaving the St. George terminal.

An interesting feature of this station is the method of ventilation. Two ducts originating in wells outside and adjacent to the front wall of the substation, run under the substation floor. Each duct divides into two parts at an easy angle, with each part terminating in the pit under each converter location. These pits are extended beyond the machine pedestals to provide grill openings to the duct just outside of the bedplate, at each end of each converter. Robertson, 54-inch, ventilators extend well above the roof on center lines between converters number 1 and 2, and 3 and 4.

A large steel door at the end of the machine room provides for the installation and removal of any of the equipment.

A small room extending into the high tension room, and opening from the machine room, accommodates the power and switching equipment for the 2300-volt supply to the signal system and to local and station light and power circuits.

Built into one corner of the machine room on the front side of the building is a two-story structure, the second floor of which is occupied by the Chief Traffic Operator. This room is reached by a flight of stairs leading up from the machine room. The first story is divided into two separate parts, one serving as a battery room, and the other, which is glazed on all exposures to the machine room is made sound proof. This room is occupied by the Traffic Operator and in it are installed the telephone and supervisory control equipments which respectively put the operation of all trains and substation equipment under its supervision.

The station is well lighted by large windows on the front side of the building exposed to view from the train sheds at St. George terminal station.

The building which is constructed of red tapestry brick is well proportioned and, from an architectural standpoint it presents a pleasing appearance which contributes well to its surroundings.

Automatic Substations

Except for slightly different arrangements, the railway substation installations at South Beach, Old Town, Eltingville and Atlantic are the same. The Atlantic substation is at the present time equipped with only one converter unit. However provision has been made for the second so that when it is installed, the station will be practically a duplicate of the three other automatic stations.

The installation at each of the automatic substations comprises an outdoor structure, which accommodates two power transformers, signal transformer and switching equipment, the high tension switching equipment, lightning arresters and outdoor metering equipment, also a brick building, housing two 1,000 kw., 60-cycle, shunt-wound synchronous converters together with the automatic switching equipment.

The two power transformers which are of the three phase OISC outdoor type are installed on concrete foundations adjacent to the substation wall. The secondary leads from these transformers enter the building through porcelain wall bushings and are racked to the inside wall down to the alternating current starting and running switches and to the conduit running under the concrete floor to the synchronous converters.

The starting switches which are direct current, solenoid operated, are mounted adjacent to the wall where the transformer leads enter the building and are grouped in pairs behind and at the ends of the automatic switchboard.

With shafts at right angles and with the alternating current ends toward the switchboard, the converters set slightly forward of the center of the room, each to one side with liberal aisle space between them. This aisle is entered from a large double door which makes the installation or removal of large equipment an easy matter.

Above and to the rear of the switchboard, supported by a steel structure, are mounted two 3,000-ampere, high-speed, direct-current circuit-breakers, one at each end of the switchboard, and between these the grid frame resistors, which are used for the automatic adjustment of overload conditions.

A long narrow room at one side of the building, opening into the machine room, contains the storage batteries for the operation of the substation and supervisory control equipment.

Ventilation is provided by large louvre openings on three sides of the building at the floor line and a 54 inch Robertson type ventilator centered over the machine room and extending well above the roof line.

Large windows in the walls just below the ceiling line on three sides of the building provide adequate daylight illumination.

Similar to the St. George substation, these stations have been designed to accommodate larger machines should such be required in the future operation of the system.

Automatic Operation—Scheme of Control

The automatic stations, which are unattended except for periodic inspection, are arranged to start automatically when the third rail voltage drops to or below some predetermined minimum. This is accomplished by means of a contact-making voltage relay which is connected across the circuits to the third rail and the running rails.

When the contacts of this voltage relay close, they must remain closed continuously for a definite length of time, measured by another relay, before the impulse will be given to start the first machine in the station. This relay precludes unnecessary starting.

After the equipment receives the starting impulse, energy supplied from the storage battery at 125 volts is supplied through the functioning of a master switch and auxiliary switches, all electrically operated, to close first, the large oil circuit-breaker in the outdoor structure to connect the 33,000-volt supply to the high voltage windings of the power transformer. This operation is followed in turn by the closing of a smaller oil circuit-breaker inside of the substation, which connects the alternating-current end of the synchronous converter to the starting taps on the low voltage windings of the power transformer.

By induction motor action, the synchronous converter reaches synchronous speed. This speed and the polarity of the direct-current end of the converter are checked by a small polarized motor relay, which functions to automatically reverse the shunt field windings of the converter, momentarily, to correct the polarity should it be reversed after starting and while still connected to the starting voltage. With correct voltage established, the polarized motor caused the starting oil switch to open and the running oil switch, which connects full voltage of the power transformer secondary to the converter to close.

Following this, the direct-current brushes, which are raised from the commutator by a motor operated mechanism before the converter is started, are then lowered to position on the commutator surface.

With the brushes in the running position, the starting impulse is relayed to the direct current switching equipment. The impulse is received by the main line breaker and the high-speed breaker, which, on closing, connect the machine to the third rail circuits through the feeder bus to which these third rail feeders are connected through automatic circuit breakers. This operation, however, leaves a resistor between the machine and the bus to guard against picking up too much load. The load is measured by a relay which, if the load is not excessive, in turn relays the impulse to a circuit-breaker which closes to shunt out the resistor and thus supply the full voltage of the converter to the third rail sections. Normal starting time, with the converter from dead rest, is approximately 30 seconds.

The relay which permitted the resistor to be shorted, however, continues to stand guard while the machine is in operation so as to again put the resistor between the machine and the feeders to the third rail should the load become excessive. When the voltage on the third rail is thus reduced by the effect of this resistor, other stations on the system are forced to assume a greater share of the load. This they are in position to do since in most cases, an overload is the result of a congestion of trains.

To protect the machine from damage due to the short circuits between the third rail and running rail, a 3000-ampere, full automatic, electrically operated high-speed circuit-breaker is connected in the machine circuit between the machine and the direct current feeder bus. Should an abrupt rise of current in excess occur, this breaker, which operates to limit the current in from four to seven and one-half thousandths of a second, opens to insert into the circuit a resistor which limits, to a safe value, the amount of current supplied to the fault. When such a condition arises, an impulse coil in the third rail feeder circuit, on which the short circut occurs, will function to open the circuit-breaker on that feeder and thus disconnect it from the substation bus. This impulse coil functions only on an abrupt rise in current such as that incident to a short circuit and will not operate on any legitimate overload conditions. As soon as the feeder breaker opens, the current is reduced to normal and the high speed circuit breaker and the resistor shunting breaker close to again restore full voltage to all feeder sections except the one on which the trouble occurs. In fact, the operations occur so quickly that an operator or a passenger on a train on another section supplied from the same substation would scarcely be aware that anything at all had happened. At night, a momentary blink in the lights would probably be noticed, that is all.

Each third rail feeder circuit is so arranged that, as soon as the feeder breaker opens, a testing circuit which comprises essentially a high resistance circuit and a voltage relay, is connected to the circuit. As soon as the short circuit is removed, the voltage relay transmits an impulse to the closing relays which operate to reclose the feeder breaker and re-establish the power circuit to that section.

The system is double tracked, Old Town, Eltingville and Atlantic substations, each third rail is sectionalized at a point immediately in front of the substation. Each section is supplied through an automatic service restoring feeder equipment, a duplicate of that described above, thus making a total of four feeder circuit panels at each of these stations. The South Beach substation is located at the end of the line and therefore only two feeder circuit equipments are required.

At Clifton Junction, the third rail is also sectionalized in all three directions. In a small station erected at this point there has been installed a tie-bus to which each of the six sections is connected through automatic service restoring switching equipment duplicate of that used in the substations.

In each case, the feeder circuit-breaker is electrically operated from energy supplied by a storage battery. Only a shunt trip mechanism, for opening the mechanical latch to effect the opening of the breaker, is provided. These

Map of Staten Island Showing Route of Electrified Line of Staten Island Rapid Transit Company

are unlike similar circuit-breakers used in manually operated railway substations since the automatic overload trip has been omitted. The shunt trip mechanism operates from energy supplied by the storage battery through the contacts of the relay operated in turn from the impulse coil or short circuit detector. Should the feeder cable heat excessively a thermostat operates to open the feeder circuit-breaker, which in this case remains open until the thermostat is reset by an inspector.

Since the breakers are mechanically latched and operated from an independent source of energy, their operation, unlike those in most automatic substations, is entirely independent of the substation bus voltage.

Bringing Into Service the Second Unit

Following the rise in temperature of the machine windings, which operates at a predetermined point to put the second converting unit into service in parallel with the first in exactly the same sequence of operation as that set into operation by the voltage relay in starting the first machine.

If the first unit be subjected to such overload as to cause the load shifting resistor to be cut into the circuit, the second unit would be automatically started after a brief time delay and in advance of any indication by the temperature relay referred to above.

The two units, operating in parallel, function with reference to the load in identically the same manner as a single unit. For example, in the event of excessive overload, the load shifting resistor shunting breakers open and close simultaneously through the functioning of a control relay common to both circuits.

Should the first unit for any reason fail to respond completely to the starting impulse, the second unit will be automatically brought into service after a brief time delay slightly longer than that normally required to bring that unit into service.

Shutting Down on Increased Demand

When the load demand on the substation falls to such a value that one machine can supply it and remains at or below this value for a predetermined length of time, the machine which was the second to be in demand, making unnecessary the operation of the first unit, will result in it also being taken out of service until further decrease in third rail voltage demands its operation.

A transfer switch provides for changing the positions of the machines in their order of operation and also provides for adding a third unit to the sequence.

Substations Have Large Overload Capacity

Since the synchronous converters used in these stations are capable of delivering 50 per cent overload for two hours after reaching a constant temperature at full load, and are also capable of operating at 300 per cent of rating momentarily, the acceleration and normal operation of trains during the non-rush hours will require the operation of only one unit in each substation. Therefore, only during periods of peak load will the operator of the second unit in any of the stations be required.

Protective Devices

In addition to the features of high-speed circuit-breaker protection, protection from abnormal overloads, and the operation of feeder circuits to clear faulty third-rail feeder sections, there are numerous other features which protect the substation equipment. Some of these are as follows:

Should the load shifting resistors, due to continued service, heat excessively, a thermostat operates to disconnect the machine from the load entirely until the resistor has cooled to a safe operating temperature, when the machine is then automatically restored to service.

Excessive temperatures of machine or transformer windings are prevented by thermal overload relays which, reduce the temperatures to safe values and then automatically restore them to service.

Temperature relays on the bearings remove and hold the machines from service until restored manually, should a machine-bearing heat excessively.

A phase balance current relay shuts the machine down in the event of unbalanced phase conditions which would prove detrimental to the operation of the equipment. If the fault is within the substation, the equipment is locked out of service until the conditions responsible for the unbalance have been corrected. If the unbalanced condition is the result of a fault outside of the substation, the equipment is merely taken out of service until the condition is corrected, when service is automatically restored.

Voltage conditions, such as excessively low voltage, unbalanced voltage, or reversed phase, are guarded against by relays which hold the equipment out of service under such conditions. These and other devices such as overload relays, overspeed devices and reverse current relays, which are part of every manually operated substation equipment, provide still further protection.

An interesting feature is an annunciator which shows by which protective device the relay is operated in each case. This is of great assistance to the inspector in locating any case of trouble that may develop. There are only five conditions which would cause a lock-out. These are: Overheated bearings, excessive overload on the primary side of the power transformers, unbalanced phase conditions within the substation equipment, overspeeding of the converter armature and failure of the automatic starting sequence.

For convenient reference, all devices are tagged with a number, which in any automatic station means that the device is used for some one purpose. This practice facilitates the understanding of the operation and renders the making and reading of wiring diagrams a simple problem. It is with the protective device numbers that the annunciators are labeled.

The Supervisory System Supplements the Automatic Control of Substations

Experience in the operation of hundreds of automatically controlled substations has demonstrated very well their superiority of performance over manually operated equipment, both from the standpoint of continuity of service and required maintenance and operating costs. However, automatic equipment set to perform a definite cycle of operations under given conditions cannot exercise judgment as to when it may be desirable to alter its performance. For example, in contemplating an unusual demand for power, it may be advantageous to have all of the converting units in a substation in operation in advance of such time as they would be brought into service automatically. Also, perhaps, due to an accident to a train which would make it necessary to discharge passengers at some point other than at a station platform, it would be desirable to deenergize the third rail as a matter of safety.

As a matter of necessity, information as to the status of the power system must be had at all times if unnecessary failure of power supply is to be avoided. To give these "human" powers of communication to the automatic substations and to provide a means by which a person intelligently informed may exercise his best judgment as to the best operation of the apparatus, a supervisory control system has been installed.

From a central point located in the Traffic Operative office at St. George substation, four wires constituting two pairs of a telephone cable, radiate to each of the four automatic substations. This cable is paper-insulated for 1500 volts between conductors and, as a whole, for 3500 volts to ground, thus rendering it safe from breakdown due to induced voltages from the high-voltage circuits which it parallels along the railroad right-of-way between substations. Great care has been exercised to prevent the grounding of any of the circuits, including those in the same cable, which are used for telephone and telegraph. Also, special vacuum tube high-voltage arresters have been provided for installation at each substation.

The equipment, which is known as the synchronous relay type provides on the traffic operators control desk, a control key and indication lamps for each device in each station for which supervisory control has been provided. These keys and lamps are of the size and similar to such devices used on telephone switchboards. Associated with these lamps and keys by which their operations are controlled, are groups of small multi-contact control relays mounted apart from the desk in a steel cabinet. A similar installation has been made at each substation. At the substation, however, the small relays in the cabinet, which are controlled by the operation of those in the cabinet at the dispatcher's station, are connected through their contacts to energize or deenergize auxiliary relays which in turn cause the devices in the substations to function in response to the operations at the control desk, initiated by the dispatcher.

The operation of sending a signal to the dispatcher to indicate the automatic operation of a device at the substation, is duplicate of that initiated by the dispatcher except that it is initiated electrically through auxiliary conacts on the device itself. In response to such operation, the dispatcher in addition to receiving an audible signal, notes the change in lamp indication that shows which device on the system operated. If the function were that of closing a circuit-breaker, the red lamp associated with that particular breaker would be lighted. Opening of the breaker would be shown by the lighting of the green lamp. Since the positions of the keys on the control desk indicate the previous status of the system, the change is immediately apparent even though the dispatcher were unaware of a change in color of the lamp indication.

Essentially the functioning of the system is as follows: Two of the four wires in the control circuit provide a step by step circuit by which similar relays at each end of the line are operated simultaneously in such a way as to keep a series of relays, each effecting the operation of the next relay in the series in absolute synchronism. Each of these relays, which is provided with a group of contacts, is assigned to one particular control circuit in the substation and to the corresponding lamp and key circuits at the traffic operator's control desk. As each relay operates, a pair of its contacts are momentarily connected to the other two wires of the control lines.

If it is desired to operate any one of the circuits, the change in the postion of the control key arrests the operation of the chain of relays after it has progressed to that position in the sequence. Thus, the second pair of wires constitutes, through the contacts of the relay at each end of the circuit, a direct metallic circuit by which the auxiliary relay in the substation is energized or deenergized to effect the operation intended. Immediately following the functioning of the device, the lamp indication is returned through the same circuit after which the relay chain is released to complete its sequence. Normally, all equipment in the supervisory system is at rest. It functions only in response to operations initiated by the traffic operator's or the automatic operations of the substation equipment.

By means of this system, the traffic operator's may open or close any of the main power circuits either on the primary side of the power transformers or on the supply from the direct-current bus to the third rail sections. Also, he is able to start or stop any of the machines in the automatic stations. In addition to control over breakers at various points on the system, through which power is supplied to the signal system, he also has an indication of the position of oil circuit-breakers on the 33,000-volt system, which are operated by the power company.

Power for the operation of the supervisory control equipment is supplied from small 48-volt storage batteries installed at each substation.

Should the supervisory system, for any reason, fail to function, the stations remain under full automatic control.

In addition to features which insure against faulty operation of the supervisory system, alarm circuits are provided to indicate open fuses, open circuits and short circuits on the line wires.

Similar supervisory control equip places the control of the power company's 33,000-volt switching equipment at Clifton Junction in the hands of their operator at the St. George substation. Through the Railway Company's supervisory control system, this same operator has con-

The railway substation equipment and the switching equipment installed in the generating station and sub-

trol of similar high-voltage circuit breakers at the Eltingville substation.

stations of the Power Company were supplied by the Westinghouse Electric and Manufacturing Company.

Snap Shots—By the Wanderer

You know how it is. An idea takes root in your brain and sprouts in more directions than one. Sometimes they may even become half mania like the head of Charles I with Mr. Dick. So here I am back again with a variant of an idea to which I gave vent a month ago.

There is a weakness in technical literature that could be readily eliminated and which, if done, would add tremendously to its value. We all know of the old saying of the value of the knowledge obtained from failures. The trouble is that a man's knowledge along these lines is usually limited to that acquired from his own failures, with little or no assistance from the failures of others. Men are not addicted to proclaiming their failures to the world. They usually shun the light of publicity and are quite content to let the matter drop to the ultimate cost of the world at large; and we all have in mind many cases of this kind.

To take two only as illustrative of the fact. First, it is not so many years ago that a modification in locomotive design was brought out that at first gave promise of very satisfactory results, but troubles soon developed that were covered and it was pushed and sold where it ought never to have been used. I do not think it an exaggeration to say that millions of dollars were wasted in its purchase and use. All of which would have been saved to the communities and railroads, if the early failures had been given the publicity they deserved.

Again take the roller or ball bearing for railway cars. It must be all of thirty or forty years since the first attempts to apply them to railway service was made. Wonderful results as to tractive resistances were obtained with new bearings and especially prepared rolling stock. Results that were shouted from the housetops and a millennium in the form of the disappearance of bearing troubles proclaimed.

After a time, however, the shouting ceased and the wonderful bearings disappeared from service and the railroad world knew them no more.

But of all these devices that have flashed like a comet into the firmament of public attention, to later swing past the sun of publicity and disappear into the darkness of oblivion, I have never seen one line as to why they failed or what happened to them under the merciless pounding to which they were subjected under a railroad car. We simply know that they were no good.

The result was that the next adventurer permitting hope for his own success to triumph over the experience of a predecessor's failure, has been obliged to traverse the same dreary road. Perhaps advancing a little farther, but always handicapped by ignorance of unattainable information already in existence. The consequence is a waste of unrecoverable energy that makes the oldtime wasteful flare of burning natural gas insignificant by comparison.

We all know, Mr. X., that those roller, ball or ring bearings which you put under a baggage car on the A. B. C. railroad, made that car so movable that a man leaning against it, when it was standing on a straight and level track, would put it into motion, and that it would not stand on ever so slight a grade unless the brakes were applied. Certainly the reduction of the coefficient of axle friction to a virtual zero was worth while.

Now, what happened? Something. For that one baggage car was, I believe, the sole exemplar of your years of labor and experimentation. It probably didn't stand up to its work. In short, it failed. At least it has always been credited with failing, and you, too, are credited with having failed.

You and a few others know why, how and where it failed. So why not be perfectly frank and tell the rest of us all about it? The dissemination of that information could not do you any possible harm, because you and your device are out of the running, and it would do the rest of us a great deal of good, especially those of us who are inclined to venture into the same field of endeavor.

We, the deprived ones, have, perhaps, no real ground for complaint. But your value to the world depends entirely upon what you do for the world that cares for you. And when you fail to tell the world what you know out of pure vanity and egotism, you are not treating it fairly and you ought to be ashamed of yourself.

It so happens that twice within the past few months I found myself in a far distant city. In purchasing my home bound ticket I bought it to an intermediate point and asked the agent, who sold it to me, if he thought it would be possible to reserve Pullman accommodations for the balance of the trip. In both cases the agent offered to telegraph for the accommodations, and when I arrived and asked for them they were awaiting me. It was a little thing but it left a pleasant impression even greater, perhaps, than the importance of the favor demanded. But it is there just the same, and stands out as a nice little example of that courtesy to the public which the passenger agents are so strenuously preaching.

Again it happened that I was in another section of the country where I was to take a trip of a few hundred miles over a line and follow it by an almost immediate return. Fearing that the actual time at the other end of the line would be too short to insure the capture of the accommodations that I wanted for the return, I asked the agent if he could telegraph for them. He replied that he could only do so at my expense by way of the Western Union. I suggested that, under the circumstances, they were not very accommodating. "No," he said, "we are not accommodating at all. You see we have a complete monopoly with no competition in our territory, and we don't have to be accommodating. Of course we, here, feel that it is a mistake, but, as it is the policy of the management, we are helpless and I am very sorry that I cannot do you the favor."

All so very courteously and smilingly expressed that no offense could possibly be taken, and yet I could not help thinking.

I thought of the present situation of that road, striving as it is to resist and gain public sympathy in its resistance to the encroachments of buss, jitney and trolley lines on its revenues. I thought of its past history which is anything but savory. How once upon a time there was a notorious character whom for the sake of identification we will call "Flashy Jack." How an intimate friend of his was made president of this road. How, when the announcement was made, an observer remarked upon the probable mistake because of the impossibility of any friend of Flashy Jack's being either scrupulous or honest, and that bad times were probably ahead for the road. And how, within a few years the prophecy, half jokingly made, came true with a vengeance and the laying bare of a colossal scandal.

As I thought of these things and the great need of the road for rehabilitation in the good opinion of men at large, I wondered whether it were really true that it could trust to human forgetfulness to let the past pass into oblivion, and that it could build up a sentiment in its favor as against the invaders of its revenue, by special pulpit pleading for a rendering of abstract justice, while in its daily intercourse with its patrons, the public, it fails in the little unnecessary courtesies of its intercourse, and with the disapproval of its own employes proclaims that because of the monopoly created by its situation it has no need to be accommodating.

Perhaps not, but it is respectively suggested that one of the best means of securing a favor is to show not only a readiness but an eagerness to do one. And one of the best means of gaining public sympathy is to show by our acts that we are deserving of it.

I have always thought it one of the most personal questions possible to ask a man as to how the world uses him. It is but another form of asking "what sort of a fellow are you anyway, and how do you treat your fellows?" For a man gets about what he gives, no more. So if a railroad wants the assistance of the community as a whole, its agents must be taught and permitted to do favors to the individuals of that community, and not to tell them that they can expect no favors, no accommodations, because it is not necessary to give them, since, if they travel in that territory, they must travel by the A. B. C. line. Perhaps that is so, and perhaps too, on the other hand, the road is beset by trolley and buss and jitney, because the monopoly has failed to grant little individual favors and public sympathy is not with it. All of what seems to me to be worthy of consideration by even the most firmly intrenched monopoly.

Pennsylvania's Fuel Conservation Campaign

A concerted effort is now under way on the Pennsylvania Railroad to obtain a wide-spread expression from firemen, enginemen,, hostlers, coal chute operators and other employes immediately concerned, of new ideas and original and helpful suggestions on the problem of saving coal. Noteworthy reductions have been made on the railroad in recent months in the number of pounds of coal consumed by locomotives per 1,000 gross ton miles, and it is believed that a general discussion of the fundamentals of coal conservation and the tricks of the trade among the men on the firing line will estimate to new heights the interest of employes and quicken their appreciation of the need for saving coal.

Locomotives on the Pennsylvania consumed approximately 15,000,000 tons of coal in 1924. The railroads of the country in 1923 bought 159,918,000 tons of coal at a cost of $537,202,000. The cost of coal represents 31 per cent of the total purchases by railroads, and 10 per cent of the total cost of transportation. Coal is, therefore, the largest item of expense, next to labor, that a railroad is called upon to meet.

As an important part of the movement, the Pennsylvania management has offered prizes of $50, $25 and $10 in the Eastern, Central and Western Regions for the best three original articles written by firemen and enginemen on the general subject of saving coal. The contest is announced in the August 1st Regional editions of "The Pennsylvania News," the employes' newspaper of the Pennsylvania Railroad, which suggests that firemen and enginemen may contribute most to the movement by discussing ways and means of saving coal chiefly in the light of their experience on engines. For the apparent purpose of getting the discussion focused on the cital elements, the Regional papers also suggest that articles intended for the competition may well be based on the writers' achievements in regard to the economical use of coal on a specific run or series of runs.

The competition will close September 30. The prize winners will be announced October 15, and later the prize articles will be published.

Shop Kinks

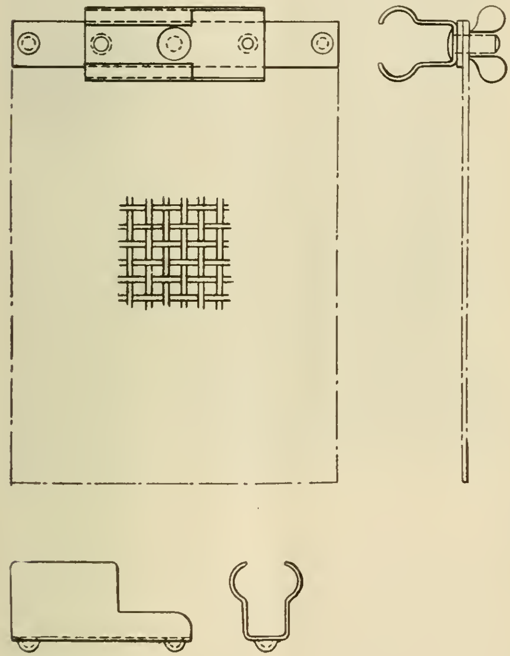
Some of the Handy Devices in Use on the Erie Railroad

A Safety Device for Handle Chisels and Punches

When rivet or bolt heads are cut off by means of a handle chisel and sledge the part cut off invariably flies off at considerable velocity. And while there is little danger of the piece striking the chisel holder or the striker, as they are behind the edge of the chisel, there is great danger of its striking and injuring some innocent by-stander.

It is in order to stop this flying piece at the start that the guard here illustrated has been designed and used.

It consists of a holder clamped to the handle and to which a piece of coarse wire netting is fastened. The clamp itself is in the form of a shoe that is driven down over the handle, on which it has a bearing 2⅜ in.



Guard for Handle Chisel and Handle Punches

long, as indicated at *A*. The buck of the clamp has a length of 4 in. and a width of 1 in. and has two circular bosses *B* raised upon it for preventing the netting from turning. The netting measures 7¼ in. by 10 in. and across one end of it, a plate of 1 in. by ⅛ in. bar is rivetted. This plate has two holes punched in it to receive the bosses on the shoe, to which it is clamped by means of a 1 in. by ⅜ in. carriage bolt provided with a thumb screw as shown.

The shoe is made of steel 1/16 in. thick and is ready bent so that the spring of the metal will hold it firmly to the handle.

When in use, the netting projects well beyond the edge of the chisel or point of the punch so that any flying piece will be caught by it.

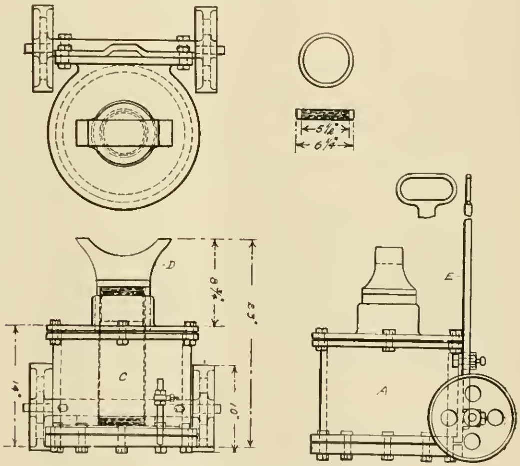
Experience has shown that a coarse meshed netting will serve the purpose, so that that used is 2½ in. by 2½ in. made of .135 master mechanics decimal gauge steel wire. This is a wire of such weight that it will not be cut or bent by the flying pieces, and the hole of about 2⅜ sq. in., large as it may appear, small enough to intercept the flying rivet or bolt heads. At the same time this coarseness serves to lessen the weight as compared with that required were a finer mesh to be used.

Air Jack for Driving Wheels

Most of the readers of this journal know that driving wheels with their axles are heavy and difficult to handle where there are no crane facilities. This difficulty is accentuated where it becomes necessary to turn them, when the difficulty seems at times to be almost insurmountable.

At the Meadville shops on the Erie Railroad the problem is met by the use of a portable air jack.

The cylinder *A* is made from an old 14 in. by 10 in. air brake cylinder having an axle *B* of 2 in. square iron



Air Jack for Driving Wheels

bolted to the flange. A pair of 10 in. diameter truck wheels completes the carrying part. The axle so that as the cylinder is tipped up and rests upon the units of the cylinder head bolts, the wheels will be raised so as to just clear the floor.

The piston is the regular brake cylinder piston and the rod *C* is made of a piece of 5 in. steel pipe. This is screwed into the piston and, at its upper end it carries a saddle in which the axle is seated, a tongue *E* is fastened to the cylinder flange for pulling the jack about.

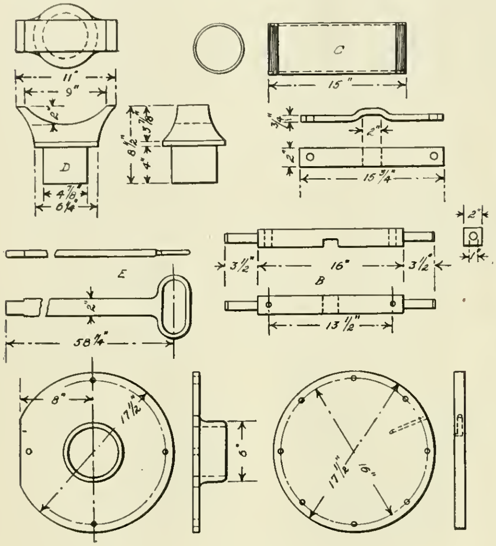
With an air pressure of 50 lb. per sq. in. the jack has a theoretical lifting power of about 7700 lbs.

The height of the lowest point of the saddle from the floor is 21 in. when the piston is in its bottom position, so that with a lift of 10 in. a pair of 66 in. drivers mounted on an 8 in. axle can be lifted 2 in. from the floor. For wheels of larger diameter it is necessary to block on top of the saddle.

When the wheels are in the air they can be turned with no resistance to be overcome beyond that of the friction of the leather piston packing against the wall of the cylinder.

Piston-rod Keyway Cutter

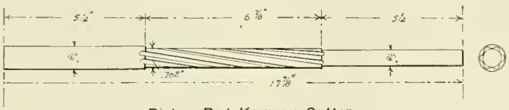
This device is simply a reamer with a cylindrical shank at each end, one of 7/8 in. and the other of 5/8 in.



Details of Air Jack for Driving Wheels

diameter. It is not intended to cut the piston-rod keyway out of the solid though it could be made to do so at an unwarranted expenditure of time and power.

The keyway should first be roughed out by drilling a series of holes, of a diameter a little less than the width of the keyway. This reamer is then fed down through an end hole. The small shank enters a bearing in the



Piston Rod Keyway Cutter

bed of the machine, and the rod is then fed over it, by which the metal left by the drilling is cut away, and a smooth, straight keyway of the desired width formed.

New Landis Pipe Threading Machine

The Landis Machine Company, Waynesboro, Pa., have placed upon the market a new design of 1/2 in. single head threading machine.

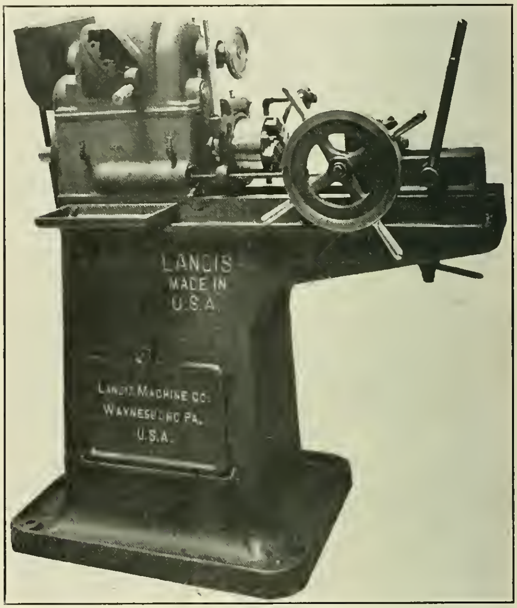
This machine has a geared headstock and single pulley drive. The main spindle has bronze bearings which insure a long life under hard service conditions.

The machine has four speeds, giving an R.P.M. of the die head of 157; 226; 315 and 441.

The die head is opened and closed automatically at predetermined limits by the carriage, or by hand. The vise has a horizontal side-wise as well as a vertical centering adjustment. This feature insures a perfect and permanent alignment with the die. This feature is exclusive with this machine.

A full supply of cooling lubricant at the die head is maintained by a rotary pump. There is a special control valve at the die head for shutting off the oil supply when necessary. The frame is cast in one piece with a fluid tight bottom. The driving pulley is mounted on top of the machine.

This machine is readily converted to motor drive. The power is transmitted from the motor shaft to the drive shaft of the machine by means of a belt. The motor is



New Landis Threading Machine

mounted on a plate supplied on top of the headstock, so as to economize floor space, and to prevent dirt and oil from accumulating on the motor parts.

The floor space occupied is 4ft. 1 1/2 in. x 1 ft. 11 1/2 in. The net weight is 950 lb.

This machine employs the Landis All Steel Rotary Die Head and the Landis Long Life Chaser.

New Freight Cars Placed in Service

A total of 83,291 freight cars was placed in service during the first six months of 1925 by Class I railroads, according to a statement issued by the Car Service Division of the A. R. A. This was an increase of 12,417 cars as compared with the number installed in the corresponding period of last year and an increase of 4,051 cars as compared with 1923. The total included 43,627 box cars, 29,504 coal cars and 3,382 refrigerator cars. There was, however, a substantial reduction in the number of new freight cars on order on July 1, to 28,197, as compared with 60,315 last year and 96,855 in 1923.

American Locomotives for Chile

Six 100-ton locomotives have been ordered from American builders for the Nitrate Railways of Chile, South America. This is the second order for American locomotives for this railway, the first six having given such excellent service that the order was duplicated. These orders are especially encouraging for American locomotive manufacturers inasmuch as the Nitrate Railways is a British owned and operated company employing no Americans.

Notes on Domestic Railroads

Locomotives

The Texas & Pacific Railway have ordered 10 locomotives of a new type from the Lima Locomotive Works. They are practically duplicates, with the addition of another pair of drivers, of the Lima 2-8-4 two cylinder design. The new locomotive will have two cylinders and a 2-10-4 wheel arrangement and will be known as the "Texas" type.

The Richmond, Fredericksburg & Potomac Railroad has placed orders for 6 locomotives, 2 Mountain type locomotives, and 2 six-wheel switching type locomotives with the American Locomotive Company and 2 Pacific type locomotives with the Baldwin Locomotive Works.

The Chesapeake & Ohio Railway has placed orders for heavy repairs to 20 Mallet locomotives with the American Locomotive Company.

The Minneapolis & St. Louis Railroad is reported to be inquiring for 30 Mikado type locomotives.

E. Atkins & Co has ordered 3 locomotives from the American Locomotive Company.

The St. Louis-San Francisco Railway, it is reported, will rebuild 10 locomotives in its own shops.

The Texas & Pacific Railway is inquiring for 10 eight-wheel switching type locomotives, 10 Santa Fe type locomotives and 5 Mountain type.

The McCloud River Railroad has ordered 2 locomotives from the American Locomotive Company.

The Chesapeake & Ohio Railway is having 10 Mallets rebuilt by the Newport News Shipbuilding & Dry Dock Co.

The Central of Georgia Railway is reported to be inquiring for 10 Santa Fe type locomotives.

The Guantanamo & Western Railroad of Cuba has placed an order for 2 Consolidation type locomotives with the American Locomotive Company.

The Punta Alegre Sugar Company of Cuba has ordered one Consolidation type locomotive from the American Locomotive Company.

The New York, New Haven & Hartford Railroad is inquiring for 10 to 20 locomotive tender trucks.

The Siamese State Railways has placed an order for 4, 3-cylinder Mikado type locomotives from the Baldwin Locomotive Works.

The Norfolk & Western Railway has placed orders for 30 locomotive tenders of 16,000 gallon capacity with the Baldwin Locomotive Works.

The Nitrate Railways of Chile has ordered 6 Mikado type locomotives from the Baldwin Locomotive Works.

The Texas & Pacific Railway have ordered 5 Mountain type locomotives from the American Locomotive Company, and 10 eight-wheel switching locomotives from the Baldwin Locomotive Works.

The Thunder & Lake Laboratory has ordered one Consolidation type locomotive from the Baldwin Locomotive Works.

The Hawaiian Sugar Company has ordered one Prairie type locomotive from the Baldwin Locomotive Works.

The St. Paul Bridge & Terminal Company has placed an order for one eight-wheel switcher with the Baldwin Locomotive Works.

The Western Lumber Company has placed an order for one Mogul type locomotive with the Baldwin Locomotive Works.

The Central Macarena Railway of Cuba has ordered one Consolidation type locomotive from the Baldwin Locomotive Works.

The Chesapeake & Ohio Railroad has placed an order for the repairs to 20 Mallet locomotives with the American Locomotive Company.

The Detroit Terminal Railroad has placed an order for 2, 8-wheel switchers with the Baldwin Locomotive Works.

It is reported that the Virginian Railway will place an order for 36 electric locomotives to cost approximately $4,815,410 with the Westinghouse Electric & Manufacturing Co.

Freight Cars

The Bangor & Aroostook Railroad has placed an order for 200 steel underframes for box cars with the Pressed Steel Car Company.

The Central of Georgia Railway is inquiring for 1,000 ventilated box cars of the 40-ton capacity.

The Texas & Pacific Railway is inquiring for 750 gondola cars.

The Andes Copper Mining Company has placed an order for 60, 40-ton ore cars with the Magor Car Company.

The National Railways of Mexico are inquiring for 50 ballast cars.

The Conemaugh & Black Lick Railroad has placed an order for 15 gondola cars and 30 coke cars with the Bethlehem Steel Company.

The Iroquois Gas Corporation has placed orders for 2, 55-ton steel hopper cars and 2, 50-ton steel underframe gondola cars with the American Car & Foundry Company.

The Baltimore & Ohio Railroad is building in its own shops 100 standard eight-wheel caboose cars, with steel underframes.

The Great Northern Railway has ordered 1,000 box car underframes from the Siems Stembel Company and 1,000 box cars and 200 flat car underframes from the Pressed Steel Car Company.

The Seaboard Air Line Railway is inquiring for 30 caboose cars.

The Pacific Fruit Express Co. has placed an order for 138 refrigerator cars with the Pacific Car & Foundry Company.

The Canadian National Railways will build in its own shops 25 caboose cars.

The Pittsburgh & West Virginia Railway has placed an order covering the repairs to 100 gondola cars with the Greenville Steel Car Company.

The St. Louis-San Francisco Railway will repair 2,600 freight cars of the various types in its own shops.

The Andes Copper Mining Company is inquiring for 66 narrow gauge dump cars for export.

The Great Northern Railway is inquiring for 250 ballast cars.

The Virginia Smelting Company has placed an order for 2 tank cars with the American Car & Foundry Company.

The Carnegie Steel Company is having 200 hopper cars repaired in the shops of the Greenville Steel Car Company and 200 in the shops of the Pressed Steel Car Company.

The White Star Refining Company, Detroit, Mich., has placed an order for 53, 50-ton tank cars of 10,050 gallon capacity with the Standard Tank Car Company.

The Berwind White Coal Company has placed orders for 1,600 mine cars with the Bethlehem Steel Company and for 540 mine cars with the Pressed Steel Car Company.

The Pennsylvania Salt Company has placed an order for 2 tank cars with the American Car & Foundry Company.

The Phillips Petroleum Company have placed an order for 300 tank cars with the Standard Tank Car Company.

The Fisher Hard Lumber Company has ordered 40 logging cars of 30 tons capacity from the American Car & Foundry Company.

The Missouri Portland Cement Company, St. Louis, Mo., has ordered 10 steel hopper cars of 50 tons capacity from the American Car & Foundry Company.

The American Railway of Porto Rico is inquiring for 20 steel gondola cars and 10 steel dump cars of 20 tons capacity.

The Lima Toledo Railroad has placed an order for 10, 40-ton box cars with the American Car & Foundry Company.

The Buffalo & Susquehanna Railroad is making inquiries for 200 steel box car underframes.

The Missouri Portland Cement Company has placed an order for 10, 50-ton steel hoppers with the American Car & Foundry Company.

The Wabash Railroad has placed an order for 12, 40-ton box cars with the American Car & Foundry Company.

The Standard Oil Company is making inquiries for 2 flat cars and 3 gondola cars of 50-ton capacity.

The St. Louis-San Francisco Railway will repair 2,600 freight cars and 30 pasenger cars in its own shops.

The Lehigh Valley Coal Co. has placed an order for 25 mine cars with the American Car & Foundry Company.

Passenger Cars

The New York Central Railroad has placed orders for 6 combination passenger and baggage gasoline rail motor cars with the J. G. Brill Co., Philadelphia, Pa.

The Erie Railroad is inquiring for 3 passenger car underframes.

The National Railways of Mexico are inquiring for 10 first class narrow gauge coaches and 20 second class narrow gauge coaches.

The Seaboard Air Line Railway is inquiring for 4 baggage mail cars.

The Pennsylvania Railroad has placed orders for 357 passenger cars of all steel construction to be delivered as soon as equipment companies can complete their construction. The order calls for as follows: 35 coaches and 5 passenger baggage-mail cars, from the Pullman Car & Mfg. Co., 70 coaches from the Standard Steel Car Company, 122 baggage cars and 15 passenger-baggage cars from the American Car & Foundry Company, 80 baggage cars and 10 baggage-mail cars from the Pressed Steel Car Company and 20 baggage cars from the St. Louis Car Company.

The Baltimore & Ohio Railroad has ordered 5 dining cars from the Pullman Car & Mfg. Corporation.

The Minneapolis, St. Paul & Sault Ste. Marie Railway has authorized the construction of a passenger motor car and a trailer in its own shops.

The Costa Rica Railway is inquiring for 4 narrow gauge coaches.

The St. Louis-San Francisco Railway is to rebuild 30 passenger cars in its own shops.

The Pennsylvania Railroad has ordered one combination baggage and mail rail motor car with trailer from the J. G. Brill Company, Philadelphia, Pa.

The Muscle Shoals, Birmingham & Pensacola Railway has ordered a gasoline rail motor car from the J. G. Brill Company, Philadelphia, Pa.

The Chicago & Alton Railroad has placed an order for one accommodation baggage and passenger car with the Oneida Mfg. Company.

The Erie Railroad is inquiring for 20 express car underframes and 5 express refrigerator car underframes.

The United Fruit Company is inquiring for 4 passenger cars for export.

The Canadian Pacific Railway has placed an order for 15 express baggage cars with the National Steel Car Company.

The Minnesota, Red Lake & Manitoba Railway has placed an order for an accommodation baggage and passenger car with the Oneida Mfg. Company.

The Gulf Coast Lines has placed an order for a number of all-steel dining cars with the St. Charles Car Works, St. Louis, Mo.

The Fruit Growers Express Company has placed an order for 400 underframes with the Pressed Steel Car Co.

The Boston & Maine Railroad has placed an order for 6 combination passenger and baggage cars with the J. G. Brill Company, Philadelphia, Pa.

The Pennsylvania Railroad has placed an order for 88 baggage and 10 baggage and mail cars with the Pressed Steel Car Company, 122 baggage and 15 passenger baggage cars with the American Car & Foundry Company; 35 coaches and 5 passenger and baggage mail cars cars to the Pullman Car & Manufacturing Corporation; 70 coaches to the Standard Steel Car Company and 20 baggage cars to the St. Louis Car Company.

The Atchison, Topeka & Santa Fe Railway is making inquiries for 4 buffet observation cars.

Buildings & Structures

The Missouri Pacific Railroad has awarded a contract covering the construction of a one-story brick roundhouse at St. Louis, Mo.

The Mobile & Ohio Railroad has awarded a contract to Dwight P. Robinson & Co., Inc., for the construction of an erection shop, heavy and light machine shops, storehouse and several smaller buildings at Iselin, near Jackson, Tenn. The total cost is estimated at $1,250,000.

The Chicago, Rock Island & Pacific Railway has awarded a contract for the construction of a one story repair shop in Chicago, Ill., to cost approximately $52,000.

The Monongahela Railroad has placed a contract covering a one-story car repair and machine shop at Brownville, Pa., to cost approximately $100,000, with the H. K. Ferguson Company.

The Seaboard Air Line Railway has awarded a contract covering the construction of a car and locomotive shop at Wildwood, Fla., to cost approximately $250,000.

The Atchison, Topeka & Santa Fe Railway has awarded a contract covering a brick roundhouse at Topeka, Kansas, to cost approximately $150,000.

The Pacific Electric Railway is reported to be planning the construction of a new maintenance shop and yards at Riverside, Calif.

The Missouri Pacific Railroad is planning the erection of a roundhouse and additional track at El Dorado, Ark.

The Texas & Pacific Railway is asking for bids on a roundhouse, repair shop, car shed and other facilities at Shreveport, La.

The Central Railroad of New Jersey has commenced construction on its shops at Bethlehem, Pa., which will include a roundhouse, car shop and new freight yards.

The Northern Pacific Railway has placed a contract covering the construction of car shop, boiler shop, battery building, store house, commissary building, and numerous other buildings at St. Paul, Minn.

The Southern Pacific Company plans the construction of a large material yard at Buckeye, Ariz.

The Baltimore & Ohio Railroad has awarded a contract covering the construction of a water supply reservoir at Lumbersport, West Va., to cost approximately $28,000.

The Norfolk & Western Railway plans the construction of a roundhouse, machine shop, store house and other shops and buildings at Williamson, West Va., to cost approximately $1,000,000.

The Erie Railroad has purchased the former plant of the Safety Car Heating & Lighting Co. in Jersey City, N. J., and it is reported will convert the property into a car repair shop.

The Atlanta Terminal Company plans the extension of sheds at the Atlantic Terminal with other improvements to cost approximately $75,000.

The Atchison, Topeka & Santa Fe Railway has awarded a contract for the erection of a 12-stall reinforced concrete roundhouse at Hutchinson, Kan.

The Yazoo & Mississippi Valley Railroad has secured options on property on which to construct a roundhouse and other facilities at Natchez, Miss.

The Pennsylvania Railroad has purchased the Schoenberger Mill property in Pittsburgh, Pa., for nearly $5,000,000. The property is to be used in connection with the Pittsburgh terminal improvement of the Pennsylvania Railroad.

The Minneapolis, St. Paul & Sault Ste. Marie Railway will enlarge the yards at Superior, Wis., at a cost of approximately $85,000.

The Pennsylvania Railroad has ordered the abandonment of its heavy repair shop at Logansport, Ind., and will transfer the heavy repair work to its shops at Columbus, Ohio, and Fort Wayne, Ind.

The New York, New Haven & Hartford Railroad has awarded a contract for the construction of a building for its shops at Van Nest Station, New York City.

The Pennsylvania Railroad and the city of Philadelphia plan to commence work in October on the project of removing the railway terminal to the west bank of the Schuylkill River in Philadelphia.

The Atlantic Coast Line Railroad has awarded a contract for a 14-stall addition to the roundhouse at Florence, So. Car.

The Florida East Coast Railway has awarded a contract for a repair shop at St. Augustine, Fla.

The Illinois Central Railroad has awarded a contract for shops and roundhouse at Sioux City, Iowa, to cost approximately $80,000. This road also announces that the contemplated improvement at Paducah, Ky., will include three principal units; locomotive erection and machine shops with 5 cranes up to 250 tons capacity; blacksmith shop, boiler shop, paint and tank shop, tin, electric shop, power house, and other repair car shops.

Items of Personal Interest

H. L. Hanna, mechanical engineer of the New York, Chicago & St. Louis Railroad has resigned.

E. Von Bergen has been appointed general air brake, lubricating and steam heat engineer of the Illinois Central Railroad with headquarters at Chicago, Ill. **A. J. Pichetto** has been appointed air brake, lubricating and steam heat inspector of the northern and western lines with headquarters at Chicago, Ill., and **T. W. Kennedy** has been appointed air brake, lubricating and steam heat inspector of the southern lines and the Yazoo & Mississippi Valley Railroad with headquarters at Memphis, Tenn.

E. B. Dailey has been appointed engineer of car construction of the Southern Pacific Company with headquarters at San Francisco, Calif., and **George B. Hart** has been appointed assistant to the general superintendent of motive power with headquarters at San Francisco, Calif.

John Roberts has been appointed general shop supervisor of the Canadian National Railways with headquarters at Montreal, Que., Canada.

C. R. Harding has been appointed engineer of standards of the Southern Pacific Company with headquarters at San Francisco, Cal., and will have supervision of all standards, other than those of motive power department, and will assist the president in engineering matters and in such duties as assigned him from time to time.

R. W. Quigley, apprentice instructor in the motive power department of the Southern Pacific Company has resigned from the service and has accepted a position as traveling representative for the International Correspondence Schools. **E. W. Pitt** has taken the position vacated by Mr. Quigley.

F. W. Mahl, who has been director of purchases of the Southern Pacific Company with headquarters at New York, has been appointed general purchasing agent with headquarters at San Francisco, Calif.

Thomas Carr Powell, for the last five years vice president in charge of traffic on the Erie Railroad, will become president of the Chicago & Eastern Illinois Railroad on August 1, to succeed **William J. Jackson** who will become chairman of the Executive Committee.

Mr. Powell's railway career started in 1884 as a traffic mail clerk with the Cincinnati, New Orleans & Texas Pacific Railroad. In 1893 he became assistant general freight manager of that road and two years later went to the Southern Railway where he saw thirty years service in the freight and traffic department.

Marvin Hughitt, who for fifteen years has been chairman of the Board of Directors of the Chicago & Northwestern Railway and its subsidiary, the Chicago, St. Paul, Minneapolis & Omaha, has resigned to become head of the finance committee of that railroad.

Mr. Hughitt is one of the oldest active railroad men in the United States. He was born in Genoa, N. Y., in 1837, and began his railroad career in Illinois as a telegrapher at the age of seventeen. In the early days he was with the Chicago & Alton and later with the Illinois Central on which road he served as division superintendent and general superintendent. In 1872 he became general superintendent of the Chicago & Northwestern and five years later was made president of the company, a position he held until 1910 when he became chairman of the Board.

W. H. Finley, president of the two roads, has resigned because of ill health. **F. W. Sargent**, vice-president and general counsel, will succeed Mr. Finley and in addition take up the duties of chairman of the Board.

T. J. Martin, formerly assistant road foreman of engines, Monongahela division of the Pennsylvania Railroad has been promoted to assistant train master Monongahela division with headquarters at Shire Oaks, Pa.

J. A. Marshall, assistant master mechanic of the Fargo division of the Northern Pacific Railway with headquarters at Staples, Minn., has beeen appointed master mechanic of the Pasco division with headquarters at Pasco, Wash., succeeding **C. A. Wirth**, deceased. **E. H. Carlson** has been appointed assistant master mechanic of the Fargo division succeeding Mr. Marshall.

W. P. Lambert has been appointed special assistant with duties to be asigned by the superintendent of motive power and equipment of the Central Railroad of New Jersey.

F. S. Schwinn has been appointed assistant chief engineer of the Gulf Coast Lines, International Great Northern Railway with headquarters at Houston, Texas.

G. M. Wilson, superintendent of motive power shops of the Canadian National Railways with headquarters at Montreal, Que., Canada, has been transferred to Stratford, Ont., succeeding **John Roberts** who has been appointed general supervisor of shop methods, with headquarters at Montreal, a newly created position. **A. McDonald** succeeded Mr. Wilson at Montreal.

E. W. Robinson has been appointed division engineer of the Port Arthur division of the Canadian National Railways.

G. C. McGorkle has been appointed roadmaster, Indianapolis division, Lake Erie & Western district of the New York, Chicago & St. Louis Railroad with headquarters at Tipton, Ind., succeeding **W. S. Fife**, transferred. **J. H. Dunn** is appointed general foreman, Ft. Wayne division with headquarters at Muncie, Ind., succeeding **G. C. McCorkle**.

G. A. Haslett has been made general road foreman of engines on the Seaboard Air Line, Southern district with headquarters at Tampa, Fla. **H. M. Agin** becomes road foreman of engines with headquarters at Tampa, Fla., **W. A. King** becomes road foreman of engines with headquarters at Wildwood, Fla., **R. H. Harris** and **J. C. Trigg** become assistant road foremen of engines with headquarters at Waldo, Fla.

W. L. Kellogg, formerly superintendent of motive power of the Missouri, Kansas & Texas Railroad was recently made secretary of the Florida West Coast Development Company and has moved his headquarters from Chicago to Parry, Fla.

A. R. Cole, master mechanic of the El Paso-Amarillo division of the Chicago, Rock Island & Pacific, with headquarters at Dalhart, Tex., has been transferred to the Oklahoma-Southern division, with headquarters at Chickasha, Okla.

Supply Trade Notes

Duff Manufacturing Co., at a recent meeting of the Board of Directors of this company, a number of changes in the officers and organizations were announced. The new officers are as follows: **J. R. McGinley**, chairman; **Thomas A. McGinley**, president; **P. G. O'Hara**, vice-president; **C. N. Thulin**, vice president; **E. M. Webb**, general manager; **F. O. Graham**, secretary; and **D. J. Greiner**, assistant treasurer.

Henry S. Mann, formerly district manager of the Chicago office and shops of the **Metal & Thermit Corporation** has resigned to become district sales manager of the **Standard Stoker Company**, with headquarters in the McCormick Building, Chicago, Ill.

Sidney Buckley has been appointed works manager of the crane department of the **Niles Bement Pond Company**, succeeding **V. O. Strobel**, resigned. **B. A. Tozer** has been appointed sales manager in the New York district, succeeding **H. F. Welch**, promoted, and **A. E. Turner** has been appointed manager at Cleveland, succeeding Mr. Tozer.

John F. Schurch has been elected president of **Manning, Maxwell & Moore, Inc.**, New York, succeeding **John M. Davis**, who has been elected president of the Delaware, Lackawanna & Western Railroad. Mr. Schurch has been vice-president and was formerly vice-president of the **T. H. Symington Company**.

The **Bucyrus Co.**, South Milwaukee, Wis., has opened a new sales office at 461 Union Trust building and announces that it will be in charge of **A. R. Hance**.

L. J. Ferderber has been appointed assistant to the first vice-president of the **General American Tank Car Company**.

Walter T. Gomley has been elected vice-president in charge of service and production of the **Franklin Railway Supply Company, Ltd.**, of Montreal, and **Adam P. Arnold**, secretary and treasurer with headquarters at Montreal. **Leland Brooks**, vice-president and treasurer, has resigned.

David Ayr has been appointed assistant plant manager of the **Pratt & Whitney Company**, Hartford, Conn.

Henrik Owensen has been appointed chief engineer of the **Youngstown Sheet & Tube Company**, Youngstown, Ohio, succeeding **Klaus Sollie**, deceased. Mr. Owensen was formerly assistant chief engineer.

Elliott A. Allen has been appointed New England district sales manager of the **Timken Roller Bearing Company** with headquarters at Boston, Mass.

T. V. Buckwalter, chief engineer of the **Timken Roller Bearing Co.**, has been made vice-president in charge of engineering.

C. W. Marshall has been appointed Eastern sales manager of **The Sunbeam Electric Mfg. Co.**, of Evansville, Ind., with headquarters at Grand Central Terminal building, New York. Mr. Marshall was formerly district manager for the **American Arch Company**, in the Chicago district.

Jesse C. Bader, formerly representative of the **McMyler Interstate Company**, with headquarters at Chicago, has been appointed western sales manager of the **Ohio Locomotive Crane Company** with headquarters at Chicago, Ill.

Elmer E. Ross, director of the **Positive Lock Washer Company**, Newark, N. J., has been elected president to succeed **George Hendricks Denman, Sr.**, deceased. Mr. Ross is the son of the late John B. Ross, originator of, and former president of the Positive Lock Washer Company.

The Waugh Equipment Company, successor to the **Waugh Draft Gear Company**, has recently announced additions to its lines of manufacture, and now announces the addition to its executive staff of **Richard J. O'Brien**, who assumes the position of general manager, and **Walter H. Bentley**, who becomes sales manager.

The office of general manager is filled by Richard J. O'Brien, who has been identified with the railroad field for many years, coming from the Phillips Exeter Academy and Brown University. Mr. O'Brien started his railroad career with the **Interboro Rapid Transit Company** of New York as assistant to the superintendent of the electrical departments. He was later connected with the **Railway Improvement Company** of New York as sales engineer, with the Eighth Field Artillery in France, with the Allied Technical Board in Siberia, with the Industrial Department of the City of Nitro, West Virginia, as industrial engineer, and with the Waugh Draft Gear Company, as assistant to the president, from which position he was promoted to his present position as general manager of the Waugh Equipment Company.

Walter Bentley, identified for the past three years with the Railway Journal, has assumed charge of the Sales Department in the capacity of sales manager of the Waugh Equipment Company.

Mr. Bentley has spent his entire working life in the railroad industry, starting back in 1904 with the Chicago & North

Western, going in 1909 to the Duluth & Iron Range and back again with the Chicago & North Western until 1911 when he was appointed sales representative for the **Baldwin Locomotive Works** and the **Standard Steel Works Company**. In 1914 he was made Western representative for the **Curtain Supply Co.**

The details of European railroading are also within Mr. Bentley's book of knowledge, as he was connected with the Railway Transportation Corps at St. Nazaire, Montoir, Angers, Cherbourg and Tours, besides railroading in Italy and Germany.

Upon his return to America in the fall of 1919, he served under the Regional Director U. S. R. A. North West Region, and later was appointed assistant secretary of the Western Society of Engineers.

These new appointments are of interest to the many friends of both men, and to the railroad fraternity at large, for both are well known among railroad men.

John P. Bourke, eastern sales manager of the **Ewald Iron Company**, Louisville, Ky., has been elected a vice-president with headquarters at 33 West 42nd Street, New York City, N. Y.

The **New York Brake Corporation** has been incorporated to manufacture railroad supplies. Headquarters of the new company will be located at Buffalo, New York.

A. E. R. Turner has been appointed sales manager of the Cleveland office of the **Niles-Bement Pond Co.** Mr. Turner comes from the **John Bertram Co., Ltd.**, at Walkerville, Canada.

L. Klopman, treasurer and general manager of the **Railway Storage Battery Car Company**, New York, has resigned to become vice-president and treasurer of the **Revivo Battery Corporation**, with factory at Garfield, N. J., and office at 46 West Twentieth St., New York City.

Obituary

Charles T. Westlake, chief mechanical engineer of the Commonwealth Steel Company, died July 22. Mr. Westlake had been connected with the company since the present management assumed control of the company in 1904, but he was connected with the company from its beginning in 1901. He superintended the erection of the original plant and was the company's first works manager. He was later transferred to the St. Louis office as chief mechanical engineer and until recent years was actively in charge of the company's mechanical department, but his physical condition seemed to require that he be relieved of all details and for the past few years he has served the company chiefly in a consulting capacity.

Carl A. Methfessel, manager of sales, eastern district, for the Duff Manufacturing Company, with headquarters at New York, died on July 22nd, at Ridgefield Park, New Jersey. Mr. Methfessel was 48 years of age and had been connected with the company for over 15 years. He was formerly connected with the Delaware, Lackawanna & Western Railroad.

Peter Walling, formerly organizer and director of the Laconia Car Company, died July 19 at his home at Winchester, Mass. Mr. Walling, who was in his 81st year, was born in Canton, Ill. His early life was spent in the railroad field. He was connected at different times with railroads of the Middle West and New England. He was first connected in the east with the old Eastern Railroad and the Boston & Maine Railroad. Later he was division superintendent of the Wisconsin Central Railroad. After this Mr. Walling organized the Laconia Car Company, which has manufactured freight cars for many years. He retired from active business life in 1916.

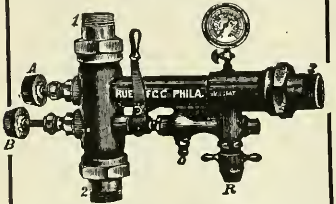
William McConway, president of the McConway & Torley Company, steel manufacturers, Pittsburgh, Pa., died July 27. Mr. McConway was a director of the Westinghouse Electric & Manufacturing Company, as well as a trustee of the Carnegie Institute and Carnegie Institute of Technology. He was 83 years of age.

New Publications

Books, Bulletins, Catalogues, etc.

A House of Chemical Engineers, is the title of a 42-page booklet recently issued by the Dearborn Chemical Company, Chicago, Ill. For years this company has been furnishing railways chemicals for water treatment to prevent scale, pitting and corroding conditions in the boilers of locomotives and power plants. This booklet presents in an attractive form, photographic views of the extensive laboratories, workshop, storage, and offices of the company. It shows pictorially the various steps in the analysis of water, some of the equipment for mixing formulae, and the packing and shipping of the finished product. It is a highly interesting little booklet, and copies may be had on application to the Dearborn Chemical Company.

Locomotive Feed Water Heaters. The Superheater Company of New York and Chicago have just issued a third edition of their instruction book covering instructions for operation and maintenance of Elesco feed water heaters. Added features of the present edition are the section giving operation instructions and the questions and answers regarding operation at the back of the book. It also gives detailed instructions covering the principle and description of the equipment, inspection and test, cleaning the heater, heater and pump repairs. Two charts at the center of the book illustrate by means of colors the passage of steam and water through the different parts of the equipment. 73 pages and cover, 4½ x 6 inches.



Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

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The Diesel Oil—Electric Locomotive and Its Performance in Service

Some Details of Its Design and Operation in Service With Economies Effected.

Early last year an electric locomotive, driven by an oil engine, the first of its kind built in America, was built jointly by the General Electric Company and the Ingersoll-Rand Company.

The engine weighs 120,000 pounds and is equipped with a 300-h.p. Deisel oil engine, adapted for burning fuel oil, of the exhaust is also mounted on the roof. Sufficient fuel can be carried for 48 hours continuous switching service.

Owing to its high economy it is free from smoke, which renders it particularly suitable for service in cities or in places where smoke is objectionable.

60-Ton Oil-Electric Locomotive Drilling Cars in Yard

manufactured by the Ingersoll-Rand Company, directly connected to a 200 kilowatt direct current generator built by the General Electric Company. The direct motive power consists of four General Electric motors, one of which is geared to each of the four axles.

A six-cylinder engine is used and designed to burn fuel oil according to the principles of the well-known Price system of direct fuel injection. This system avoids the use of high pressure injection and also effects a reduction in weight, an improvement in mechanical efficiency and increased simplicity and reliability. The fuel is injected into the various cylinders through a distributor by a single acting plunger type pump.

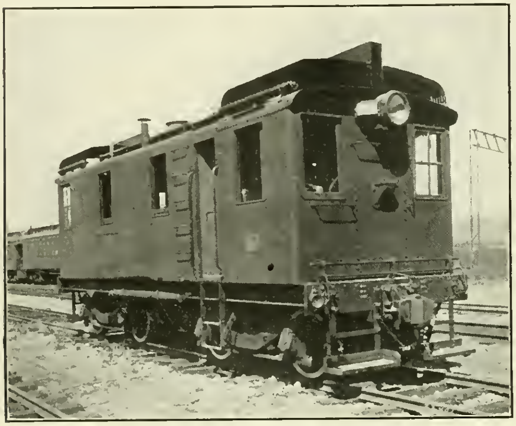
All parts of the cylinders, cylinder heads and combustion chambers are water cooled. The water from the water jackets passes to a radiator located on the roof and a thermostat maintains an even temperature irrespective of weather conditions. The muffler for reducing the noise

The unusual feature of the design of this locomotive is the use of a direct current generator supplying current to the motors without intervening accelerating resistances. This is accomplished by using a differential series field on the generator, which automatically reduces the generator voltage with the increase in the amount of current drawn by the motors.

The engine frames and running gear were built by the American Locomotive Company. The tractive effort is placed at 36,000 pounds or 30% of the weight of the engine, all of which, as previously indicated, is upon the driving wheels.

The engine has now been in service on a number of roads for something more than a year and the data obtained during that time give a clear idea of the economical working of the machine. In this period it has been in service for approximately 2,225 hours and has run about 5,220 miles. This low mileage for the total time that the engine has been in service is explained by the fact that the service has been almost exclusively in switching-work upon which comment is made in another column.

In presenting the data pertaining to the performance of the locomotive, the low percentage of the load factor is emphasized, in order to show what the locomotive was capable of doing, had it been worked to its full capacity. In making this calculation it is assumed that the machine



60-Ton Oil-Electric Locomotive Showing Cooling Apparatus on Roof

is capable of developing its full rated capacity of 200 kilowatts per hour for every hour that it is credited with having been in operating service. So that, taking the service on the New York Central as an example, the engine was in service for 833 hours, with the oil engine in operation for 579.33 hours of that time, which, with a rating of 200 kilowatts per hour would have given 115,866 kilowatt hours available: whereas as a matter of fact, only 15,063 kilowatt hours were generated, or 13 per cent. of the available amount. This is here called the load factor.

This load factor was only 16.6 per cent. for the whole of the time during which the locomotive has been in service and is accounted for as already stated by that service having been in switching, where the engine is standing for a large portion of the time. In this case where the standing time amounted to or was more than ten consecutive minutes, the engine was stopped, and this, in turn, accounts for the 253.66 hours that the engine was idle out of the 833 hours that it was in service on the New York Central.

This is one of the economical advantages of the type of engine, that, when there is to be an idle or standing interval, the engine can be stopped and with it all consumption of fuel.

As the work on the New York Central involved the greatest number of hours of service and the greatest mileage made in any of the tests, it may be taken as a basis of probable costs.

In this test and in all of the others the prices charged for supplies are as follows:

Fuel oil, per gallon	$.05
Lubricating oil per gallon	.50
Water per 1,000 cubic feet	1.00
Gasoline, per gallon	.11

On this basis the costs for the operation of the engine on the New York Central were as follows:

Total cost of fuel and water	$247.00
Total cost of oil and gasoline	.86
Cost per hour of oil engine operation	.427
" " " " locomotive service	.297
" " kilowatt hour generated	.01645
" " 1,000 ton miles	.67
" " mile	.162

During the period of its operation on the New York Central the engine hauled 400,000 ton miles and ran a total of 1,531 miles. This gives an engine mileage of about 1.84 miles an hour for the time that the engine was in service or about 2.64 miles per hour for the 579.33 hours during which the oil engine was in operation.

Out of the 2,227.5 hours that the engine was in service the oil engine was in operation for 1,743.13 hours or 78.2 per cent. of the time, and even during that time the engine was rarely working to its full capacity, any more than the ordinary switching engine would have been.

Among the roads on which the total mileage was more than 300 the average mileage was highest on the New York, New Haven and Hartford. Here the engine was in service for 271 hours, with the oil engine in operation for 222.75 hours of that time and the total mileage was 917 or an average of 3.3 miles per hour for the time that the engine was in service and 4.12 for the period of oil engine operation. The costs here were as follows:

Total cost of fuel and water	$88.00
" " " oil and gasoline	.74
Cost per hour of oil engine operation	.399
" " " " locomotive service	.327
" " kilowatt hour generated	.00946
" " mile	.097

In this service the ton mileage is not given.

It is, perhaps, hardly fair to make an assumption from a comparison of two tests, but if such a comparison were to be made between the services on the New York Central and the New Haven it would indicate that, with the higher proportional time that the oil engine is in operation the lower will be the cost of its operation per hour, and, naturally the higher the cost per hour that the engine is in service, for if the oil engine were to stand idle throughout the whole of the time that the locomotive is supposed to be in service, the cost would be reduced to nothing.

On the New York Central where the engine was in operation on the streets of New York City, the work was necessarily slow and not comparable with the performance on the New Haven, where it was in railroad yard service under different conditions.

On two occasions a comparative test was made between this oil-electric locomotive and a Shay locomotive. Both tests were made at the Thirty-third Street New York yards of the New York Central. In one case the duration of the test was one week and in the other it was for two weeks.

In the first test of one week's duration both engines were in service for 48 hours. The following are the general results obtained:

	Oil-Electric	Shay
Idle hours	9.58	14.66
Fuel consumed	153.5 gals. oil	7.5 tons coal
Lubricating oil used	14.5 "	1.28 gals.
Total cost of fuel and water	$14.00	$86.00
Cost per hour of engine operation	.366	3.69
Cost per hour of locomotive service	.293	1.695
Cost per 1,000 ton miles	.543	3.82
Total ton miles	25,905	22,516

The second test was one of two weeks' duration and gave the following results:

	Oil-Electric	Shay
Hours of locomotive service	280	288
Fuel consumed	673.7 gals. oil	45.56 tons coal
Lubricating oil used	80. "	3.31 gals.
Total cost of fuel and water	$73.00	$462.00
Cost per hour of locomotive service	$.263	1.605
Miles run	466	445.6
Cost per mile	$.158	$1.04

Some of the economic results of the experimental service are significant. The locomotive was in switching service from June 9th to August 23d., 1924, part of the time in twenty-four hour service handling three shifts per day with only such inspection as was possible at the time of changing crews. During this time the engine used 2,400 gallons of fuel oil equivalent to 4.15 gallons per hour of engine operation. The tonnage moved in this time was 400,000 ton miles or 166 ton miles per gallon of fuel. With a load factor of 13 per cent the engine produced 6.3 kw. hr. per gallons of fuel. At full load it is capable of developing about ten (10) kw. hr. per gallon.

The following table has been compiled to show in greater detail than above, the performance of the engine under various conditions:

	"A"	"B"	"C"	"D"
1. Total hours of locotive service	833	280	10	35
2. Total hours of oil engine operation	579.33	164	9.24	28.66
3. Total KW. hours generated	15,063	4098	520	499
4. Percent load factor	13%	12.05%	28.2%	8.7%
5. Total gallons fuel consumed	2400	672	54.5	80.75
6. Total gallons lubricating oil consumed	249	80	4	12
7. Total cu. ft. cooling water consumed	67	neg.	neg.	neg.
8. Total gallons gasoline consumed	30	neg.	neg.	neg.
9. Cost of operation (Fuel plus lubricating oil plus water plus gasoline)	$247.86	$73.60	$4.72	$10.37
10. Cost of operating per hour of locomotive service	$ 0.297	$0.265	$0.472	$0.297
11. Cost of operation per kilowatt hour generated	1.645c	1.8c	0.91c	2.08c
12. Total ton miles	400,000	112,930	16,615	......
13. Cost of operation per 1,000 ton miles	$0.67	$0.652	$0.284	......
14. Miles traveled	1531	466	47	42

"A"—Switching service. June 9th to August 23rd inclusive.

"B"—Two weeks switching service test July 24th to August 7th inclusive. Twenty-four hours per day service.

"C"—Main line local freight service.

"D"—Light Yard Drilling. September 5th to September 9th, inclusive.

NOTE—Cost of operation shown above based on the following prices:

Fuel oil at 5 cents per gallon.
Lubricating oil at 50 cents per gallon.
Cooling water at $1.00 per 1,000 cubic feet.
Gasoline at 11 cents per gallon.

In order to determine the amount of wear in the various parts of the oil engine a system of regular inspections has been maintained. The first inspection was conducted on February 12, 1924, and six months later, on September 12th of the same year, the second inspection was held at the Ingersoll-Rand Company Shops, Phillipsburg, New Jersey. The result of this inspection showed practically no wear in the six months service. The maximum wear on the wrist pins amounted to .008 of an inch.

After the crank pin, wrist pin and main bearings were set up to standard clearances, the engine was closed exactly as it was taken apart as it was found unnecessary to remove any parts.

The characteristics of this type of locomotive for various services as thus far developed are:

(*A*) *Locomotive for slow speed switching service*—

Weight of locomotive	60 tons.
Capacity of oil engine	300 h.p.
Maximum speed	30 mi. per hr.
Rated tractive effort	36,000 lbs.
Tractive effort at 14 m.p.h	6,300 lbs.

(*B*) *Locomotive for road service*—

Weight of locomotive	60 tons.
Capacity of oil engine	300 h.p.
Maximum speed	45 mi. per hr.
Rated tractive effort	23,000 lbs.
Tractive effort at 21 m.p.h	4,000 lbs.

(*C*) *Locomotive for slow speed switching service*—

Weight of locomotive	100 tons.
Capacity of oil engine	600 h.p.
Maximum speed	30 mi. per hr.
Rated tractive effort	60,000 lbs.
Tractive effort, at 10 mi. per hour	15,500 lbs.

(*D*) *Locomotive for road service*—

Weight of locomotive	85 tons.
Capacity of oil engine	600 h.p.
Maximum speed	55 mi. per hr.
Rated tractive effort	54,000 lbs.
Tractive effort at 25 m.p.h	6,200 lbs.

The general data for this 60-ton locomotive for slow switching service are:

Engine—

Type of engine	Ingersoll-Rand, 4 cycle, vertical.
No. of cylinders	6
Cylinder dimensions	10-in. bore by 12-in. stroke.
Speed	600 r.p.m.
Capacity	300 h.p.
Fuel	Fuel oil.
" injection	Direct injection.
" distribution	Rotating distributing valve.
Lubrication	Forced feed with filtration.
Lubricating pumps	Pressure pump and filter in crank case.
Cooling	Water cooled.
Radiator	Fin tube roof type 1,200 sq. ft. surface.
Temperature control	Thermostat and by-pass.
Fuel consumption	0.43 lbs. per b.h.p. hr.
Piston speed	1,200 ft. per min.

Generator—

Type	TDC-6-200 KW., 600 r.p.m. 600 volts.
Exciter	6 kw. direct connected, 60 volt.

Shunt windings... Separately excited.
Series winding.... Differential compound.
Voltage variation.. 200 to 750 volts.

Motors—

No. of motors.......
4—Type RM-840, nominal rating 95 h.p., each 600 volts.

Connection .2 in. parallel. Series and parallel grouping.

Gearing ....14 tooth pinion, 82 tooth gear.

Control—

Method of control....
By throttle lever—Automatic control of voltage 2-C-173-A controllers with electro-magnetic contractors and reverser.

Battery (for lighting and control) ......
16 cells MV-7 Exide Ironclad.

Compressors—

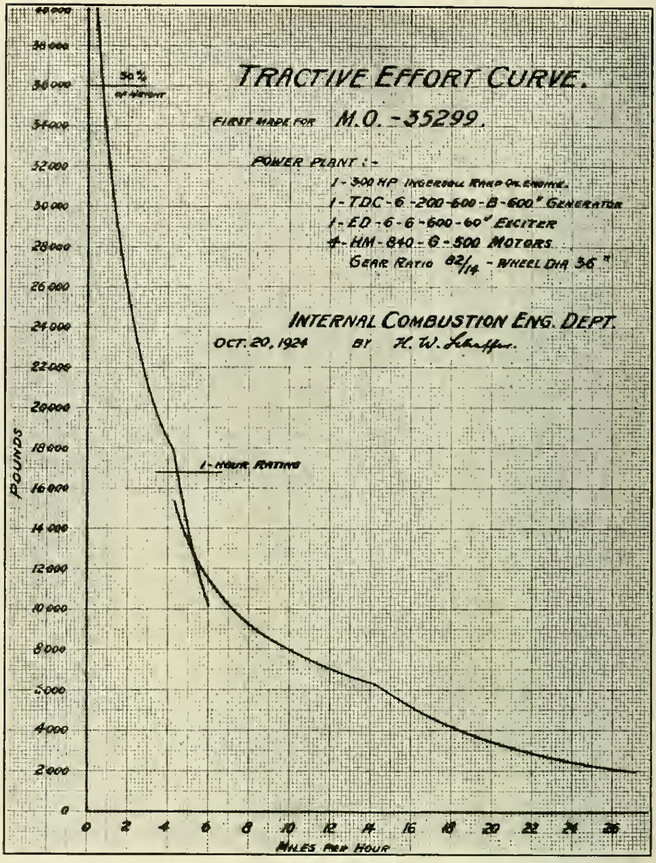
1-Type CP-26-600 volt with a piston displacement of 100 cu. ft. per minute for air brakes.

1-Mechanically driven pump mounted on engine furnished air for starting.

1-Auxiliary engine driven compressor to furnish air for starting the oil engine.

Locomotive—

Length inside knuckles 32 feet 6 inches.
Width of cab........ 9 feet 4 inches.
Trucks .... 2 axle swivel type.
Width overall........ 10 feet 0 inch.
Rigid wheel base..... 7 feet 2 inches.
Wt. complete ....120,000 pounds.
Wt. on drivers....... 120,000 pounds.
Wt. on each axle..... 30,000 pounds.
Tractive effort........ 36,000 pounds at 30% factor of adhesion maintained to 1.0 M.P.H. (approx.)



Curve Showing Fall in Tractive Effort as Speed Increases With 60-Ton Oil-Electric Locomotive

The data on the 60 ton locomotive for road service are practically the same as above excepting for the necessary modifications in type of motors and gearing.

Like the steam locomotive, the tractive effort available falls with the increase of speed, but this drop is more rapid with the oil-electric locomotive than with the steam engine. The accompanying curve of tractive effort has been worked out for the power plant portion of the machine and shows this drop very effectively.

With the assumption that the maximum tractive effort that it is possible to exert is 30 per cent. of the weight of the locomotive, we find that this is available only at speeds of 0.8 mile an hour or less. As the speed increases it falls very rapidly and at a speed of 2 miles an hour it has fallen from the 30 per cent. or 36,000 pounds to 26,000 pounds. At four miles per hour it has fallen to 18,400 pounds. This on a one hour's rating. The fall from this point on is less rapid and at ten miles an hour it is 8,000 pounds. And then as the speed is still further increased it falls to 2,000 pounds at 27 miles per hour.

It is reported that larger oil-electric locomotives of similar design are now under development by the same interests. These will be equipped with oil engines of greater horsepower rating, resulting in higher tractive effort and increased speed. It is claimed that these proposed larger units will compare favorably with branch line and main line steam locomotive performance.

Market for American Locomotives in South Africa

For the first time since the post war slump American locomotives have been delivered for use on the express mail trains between Cape Town and Johannesburg. Competition for the order of these locomotives was keen. British prices were considerably above the American, but German quotations were approximately 50 per cent lower. An order for four special type locomotives was placed with an American manufacturer and 21 with F. A. Maffei of Munich, Bavaria. The delivery of the American locomotives was on the stipulated date, but the German manufacturer has not been able to fulfill the agreement. A forfeiture of 10 per cent furnished by the German firm and a further forfeiture of 2 per cent per week are being incurred. In view of the extremely low quotation made by the German firm the completion of the contract will probably involve a heavy loss.

The New 4-10-2 Type Three-Cylinder Locomotive for the Southern Pacific Railroad

The Most Powerful Non-Articulated Locomotive Ever Built

The first of the lot of 16 three-cylinder locomotives of the 4-10-2 type under construction by the American Locomotive Company for the Southern Pacific were delivered in June, and the others are being delivered as completed. As this is the introduction of the 4-10-2 type wheel arrangement, these locomotives are known as the "Southern Pacific" type, and particularly on that road. They will be used for hauling passenger and freight trains over the Sierra Nevada mountains where the maximum grade is 2.2 per cent.

The locomotive weighs 442,000 lb. of which 316,000 lb. is on the drivers; 65,500 lb. on the front truck, and 60,500 on the rear truck. They carry 225 lb. boiler pressure. The cylinders are 25 in. in diameter; the strokes of the outside cylinders being 32 in., and the inside cylinder 28 in. The driving wheels are 63½ in. in diameter. With a cut-off of 70% they develop a tractive force of 83,500 lb., which is increased to 95,700 lb. by the booster.

The boiler is 49 ft. 1¾ in. in length; the inside diameter at the first ring being 88 5/16 in. The firebox is provided with a combustion chamber 74 in. in length. The superheater consists of 50 elements.

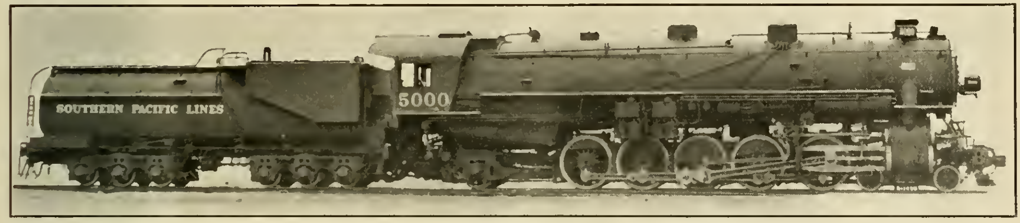
The Bradford front end throttle is located in the smokebox between the superheater header and the cylinders, no damper being required with this arrangement.

The locomotive is fitted with the Worthington type of feed water heater, which is located on the left hand side. All the auxiliaries, such as feed water heater, air compressors, booster, headlight generator, oil atomizer and blower use superheated steam.

Steam distribution to the cylinders is effected by the Walschaert valve gearing applied direct to the outside cylinders. The valve stems of the two outside steam chests are extended and connected just ahead of the steam chest by the arrangement of levers used to operate the valve for the third cylinder as in the other three cylinder locomotives previously built by the American Locomotive Company. The valve chambers are bushed to take 11 in. piston valve. The Alco type E power reverse gear is employed.

The middle main rod of a three-cylinder locomotive is rather difficult to get at for repairs. In order to reduce the wear of the bushings to a minimum, these rods are provided with an adjustable front end with rotor bushings and a strap back end with floating bushings. The back bushing, which fits over the crank axle of the second pair of drivers, is divided into three parts. It contains four rows of 5/16 in. holes, 12 holes in each row, alternately spaced. The holes are countersunk ¾ in. on the outside. This arrangement provides for equal distribution of the lubricant as the bushing moves in its fit around the pin. The strap dovetails on the body of the rod and is held in place by three 1¾ in. bolts tapered 1/16 in. in 12 in. Two nuts are put on the end of each bolt which are prevented from coming off by No. 4 taper pins, 2½ in. long. The weight of the rod is reduced by an opening through back end of the rod.

The cylindrical type of tender used is mounted on a Commonwealth one-piece cast steel frame, which is supported by 2 six-wheeled trucks, which are also made by the Commonwealth Steel Company. The capacity of the tender is 12,000 gal. of water, and 4,000 gal. of fuel oil. Franklin radio buffers are used between the tender and the locomotive. Other interesting particulars are given in the accompanying table.



4-10-2 Type Three-Cylinder Locomotive of the Southern Pacific Railroad

Table of Dimensions, Weights and Proportions of Southern Pacific Locomotive No. 5000

Builder	American Locomotive Co.
Type of locomotive	4-10-2
Service	Passenger
Cylinders, diameter and stroke	2-25 in. by 32 in. 1-25 in. by 28 in.
Valve gear, type	Walschaert
Weights in working order:	
On drivers	316,000 lb.
On front truck	65,500 lb.
On trailing truck	60,500 lb.
Total engine	442,000 lb.
Tender	244,000 lb.
Wheel base:	
Driving	22 ft. 10 in.
Rigid	16 ft. 9 in.
Total engine	45 ft. 3 in.
Total engine and tender	87 ft. 3¼ in.
Driving wheels diameter outside tire	63½ in.
Boiler:	
Type	Inverted wagon top
Steam pressure	225 lb.
Fuel	Oil
Diameter, first ring, inside	88 5/16 in.
Firebox, length and width	126⅛ in. by 102¼ in.
Combustion chamber length	74 in.
Tubes, number and diameter	261-2¼ in.
Flues, number and diameter	50-5½ in.
Length over tube sheets	23 ft. 6 in.
Grate area	89.6 sq. ft.

Heating surface:	
Firebox, comb. Chamber and arch tubes	390 sq. ft.
Tubes	3,600 sq. ft.
Flues	1,686 sq. ft.
Total evaporative	5,676 sq. ft.
Superheating	1,500 sq. ft.
Comb. evaporative and superheating	7,176 sq. ft.
Tender:	
Style	Cylindrical
Water capacity	12,000 gal.
Fuel capacity	4,400 gal. (oil)
General data estimated	
Rated tractive force, 70 per cent	83,500 lb.
Comb. heat surface ÷ grate area	79.9
Weight proportions:	
Weight on drivers ÷ total weight engine per cent	71.6
Weight on drivers ÷ tractive force	3.61
Total weight engine ÷ comb. heat surface	61.5
Boiler proportions:	
Tractive force ÷ comb. heat surface	11.63
Tractive force × dia. drivers ÷ comb. heat surface	7.38
Firebox heat surface ÷ grate area	4.35
Firebox heat. surface, per cent of evap. heat surface	6.87
Superheater surface per cent of evap. heat surface	26.41

Consolidation Type Locomotives for the Lehigh & Hudson River Ry.

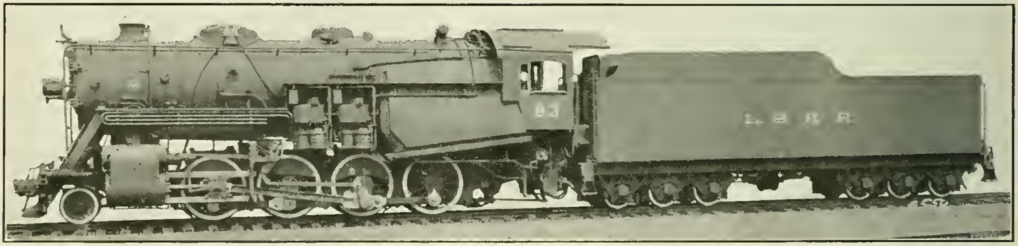
The Lehigh & Hudson River Ry., a road operating nearly 100 miles of line in northern New Jersey and south-eastern New York, has recently received, from The Baldwin Locomotive Works, four Consolidation type locomotives which are notable because of their weight and hauling capacity. This line has connection with the Lehigh Valley R. R. and the Central R. R. of New Jersey, and the traffic which it handles consists largely of hard coal. Heretofore, this traffic has been hauled chiefly by Consolidation type locomotives having a total weight of about 190,000 pounds, and by two classes of Mikado type locomotives; the first built by The Baldwin Locomotive Works in 1916, and the second by the same builders, to United States Railroad Administration designs, in 1918. The principal dimensions of these two Mikados, and of the new Consolidations, are given in the following table:—

Type	Date	Cylinders	Drivers	Steam press	Grate area	Water heating surface	Superheating surface	Weight on drivers	Weight total engine	Tractive force
2-8-2	1916	25"x30"	56"	190	100	4,155	964	212,700	285,400	54,200
U.S.R.A. 2-8-2	1918	26"x30"	63"	200	66.7	3,777	945	221,500	290,800	54,800
2-8-0	1925	27"x32"	61"	220	100	3,607	924	283,800	309,700	71,500

The earlier Mikados and the new Consolidations were designed to burn a mixture of buckwheat anthracite and soft coal, hence their large grate areas as compared with the U. S. R. A. Mikados, which were designed for soft coal only. The boilers of the 1916 and 1925 designs both have fireboxes of the modified Wootten type, without combustion chambers. The grates are of the same length and width in the two types, and the grate castings interchange. The heating surface and grate area of the Consolidation type, in proportion to the tractive force exerted, are less than in the Mikado, but this is no special handicap in view of the slow-speed drag service in which the Consolidations are used.

The boilers of the new Consolidations are of the straight top type, with tubes 15 ft. 6 in. long. A superheater of 50 elements is applied. The firebox contains a brick arch supported on six 3-inch tubes, and there is a full installation of flexible stay-bolts in the water spaces. The boiler is fired by a Duplex stoker.

The steam distribution is controlled by 14-inch piston valves, which are set with a travel of 6½ inches and a lead of 3/16 in. The steam lap is one inch, and the exhaust clearance 0 in. The Walschaerts valve gear is applied, and is controlled by a Ragonnet type "B" power reverse.



Consolidation or 2-8-0 Type Locomotive of the Lehigh & Hudson River Railway

These locomotives, although designed to traverse curves as sharp as 18 degrees, have flanged tires on all the wheels. The leading truck is of the constant resistance type, with rolled steel wheels. The locomotives are equipped with two 8½ in. cross-compound pumps and air brakes are on all driving and tender wheels.

The tender is long, with a low center of gravity, and a rectangular tank having capacity for 15,000 gallons of water and 16 tons of coal. The trucks are of the six-wheeled type, and the frame is a Commonwealth steel casting in one piece.

This is an interesting application of the Consolidation type to special service conditions where the 2-8-0 wheel arrangement can be efficiently used. The locomotives represent, in weight and hauling capacity, the maximum permitted by the clearance and wheel load limitations on this road. Further particulars are given in the table of dimensions.

PRINCIPAL WEIGHTS AND DIMENSIONS.

Gauge	4 ft. 8½ in.
Cylinders	27 in. by 32 in.
Valves	Piston—14 in. diameter
Boiler:	
Type	Straight top
Diameter	88 in.
Steam pressure	220 lbs.
Fuel	Hard and soft coal mixed
Firebox:	
Material	Steel
Staying	Radial
Length	126⅛ in.
Width	114¼ in.
Depth, front	84¼ in.
Depth, back	65 in.
Grate area	100 sq. ft.
Tubes and flues:	
Tubes	
Number	240
Diameter	2¼ in.
Length	15 ft. 6 in.
Flues	
Number	50
Diameter	5½ in.
Length	15 ft. 6 in.
Heating surface:	
Firebox	272 sq. ft.
Tubes	3,289 sq. ft.
Firebrick tubes	46 sq. ft.
Total	3,607 sq. in.
Superheater	924 sq. ft.
Driving wheels:	
Diameter, outside	61 in.
Diameter, center	54 in.
Journals, main	12 in. by 13 in.
Journals, others	11 in. by 13 in.
Engine truck wheels:	
Diameter	33 in.
Journals	6½ in. by 12 in.
Wheel base:	
Driving	17 ft. 6 in
Rigid	17 ft. 6 in.
Total engine	27 ft. 6 in.
Total engine and tender	74 ft. 10¾ in.
Weight in working order:	
On driving wheels	283,000 lbs.
On truck	25,900 lbs.
Total engine	309,700 lbs.
Total engine and tender	576,200 lbs.
Tender:	
Wheels, number	12
Wheels, diameter	33 in.
Journals	6 in. by 11 in.
Water	15,000 U. S. gallons
Fuel	16 tons
Tractive force	71,500 lbs.
Service	Freight

Repairing Locomotive Frames

In a paper read before the convention of The International Railroad Master Blacksmith's Association, which was held in Cleveland, Ohio, August 18, 19 and 20, P. T. Lavinder of the Norfolk & Western Railroad, Roanoke, Va., presented a paper on the repair of locomotive frames, in which he referred to the various methods used in making the repairs and pointing out the ones that have proved most successful on the road with which he is connected. The following is an abstract from Mr. Lavinder's paper:

We formerly used the electric welding process exclusively in repairing broken locomotive frames, with the exception of the Smith Shop forge welds, but the electric welding process has been replaced by the oxy-acetylene welding process, when welding frames in positions on the engine, due to the fact that better results have been obtained by the latter process.

When a frame is removed from the engine and welding is necessary we would recommend that it be forge welded in the Smith Shop.

The following is a complete record of the results obtained on our railroad during the past seventeen (17) months by the various welding processes.

Kind of Weld	No. Welds Made.	No. Failed Welds.	Percent Failures.
Oxy-Acetylene	757	28	3-7/10%
Smith Shop Forge	12	0	0
Electric	58	14	24
Totals	827	42	5

In making oxy-acetylene welds on locomotive frames we proceed as follows:

(1) Remove all parts necessary to provide expansion and to allow free access to both sides of the frame.

(2) Make sure frame is in line and properly blocked so that it will stay in perfect alignment during welding.

(3) Tram frame (using one piece tram) and have tram marks (if possible) not closer than 12 in. to break.

(4) V out frame all the way through from both sides at 45 degree angles using the oxy-acetylene cutting process.

(5) Spread the frame for expansion allowing ¼ in. to ⅜ in. according to size of frame.

(6) The scarfs of the V must be chipped or brought to a red heat and cleaned off with the welding torch to remove all burnt metal before starting the weld.

(7) Use a plate under all vertical welds, the plate should stand away from the frame ⅛ in. to allow perfect fusion at bottom of weld. When weld is completed remove plate and finish smoothly on bottom with welding torch.

(8) When broken in weld always cut out all of old weld and make new weld on good sound metal.

(9) If this makes a gap over 2 in. in center of V cut out section of frame not shorter than 6 in. and weld in new piece.

(10) In some locations where old welds have been made or where flaws are found a new section is welded in.

(11) On frames 5 in. x 6 in. or larger a preheating furnace is used and a charcoal or coke fire is carried around the frame at point of weld during the welding and when the weld is completed the furnace is removed and the weld is wrapped with asbestos to permit slow cooling.

(12) On smaller frames the frame is wrapped with asbestos for a distance of 12 in. on each side of the weld to hold the heat during the operation, and when the weld is finished the weld is wrapped with asbestos to permit slow cooling.

(13) When a weld is started it must be continued and never allowed to cool down until finished, and must be welded from both sides at the same time.

(14) All welds are reinforced not less than 20 per cent when clearance will permit.

(15) The spreader is generally removed immediately after completing the weld, but good judgment must be used in this matter as there is sometimes danger of upsetting if the spreader is removed too soon.

(16) Successful frame welding will depend upon two main factors, namely: proper preparation and competent welders.

We attach a record plate to all frame welds showing the engine number, name of welders, kind of weld, place and date welded. The plate is numbered showing the number of times the frame has been welded in the same location. A report is then made to the office of Superintendent Motive Power giving the same information, and in case a weld fails the record plate is removed and sent to the office of Superintendent Motive Power. This making it possible to keep a complete record of all frame welding.

All welding operations are followed up by a competent welding supervisor whose duty it is to keep a very close check as to the cost of the different operations, and by which process or methods they can be done the cheapest.

Locomotive Roundhouses and Terminals

Report to the International Railway Congress, London, England, on Question VI "Locomotive Sheds"

By R. W. BELL, Gen. Supt. Motive Power, Illinois Central Railroad

A locomotive terminal designed for the prompt and economical handling of engines must necessarily be laid out with a view of locating all facilities in such a manner as to provide convenient movement of engines from facility to facility without delay or conflicting movements.

Most locomotive terminals have rush periods during twenty-four hours, during which a large number of engines either arrive or depart within a short space of time and all facilities must be of ample capacity to handle engines promptly during these congested periods. This is particularly true on railroads located in territory where long and severe winters are experienced and where engines must be placed in the roundhouse as quickly as possible after arriving at terminals to receive the necessary attention and preparation for the next trip.

The main particulars of a busy locomotive terminal consist of an enginehouse of ample capacity to house all engines during their lay-over period; a strong, substantial turntable, operated by power, preferably motor drive; cinder pits; coaling station; sand drying house with sand bin storage; water cranes or pen stocks; machine shop; blacksmith shop; office; storehouse and oil house; engine men's tool equipment building; power house, and necessary wash rooms; locker rooms and toilet facilities. Sleeping quarters and rest rooms should be provided where necessary to take care of engine men during their lay-off period when away from their home terminal. Separate inbound and outbound engine tracks from turntable to train yard lead are essential and provision should be made for storage of both inbound and outbound engines, with the greater parking space on the inbound track.

Inbound Storage at Entrance

Practices and opinions differ somewhat as to the relative location to each other of the various facilities mentioned above, but the arrangement most generally followed provides for inbound storage at the entrance to the locomotive terminal.

From this parking space the engines pass to the coaling station for coal where provision is also made for sanding the engines at the same time. Engines are then moved to the cinder pits for cleaning fires and ash pans, and from there to the turntable and into the engine house.

Outbound engines after leaving the turntable pass the engine men's tool equipment building where they receive the engine men's tool kits, oil cans, pick, shovel and supplies which have previously been removed from the engine when on the inbound track, and thence to the pen stock, coaling station and outbound storage space.

All engine moves from the inbound storage to the outbound storage are made by hostlers, the engine men leaving the engines on arrival at the inbound storage and receiving them at the outbound storage, fully equipped and prepared for service.

Pen stocks should be located near the entrance to the inbound storage and the exit of the outbound storage. Additional pen stocks should also be provided on both the inbound and outbound engine leads near the roundhouse. At large engine terminals two or more inbound and outbound tracks are required to facilitate the handling of engines.

Should Handle Day's Supply

The coaling station should have storage capacity to meet the requirements of the terminal for twenty-four hours if necessary, without elevating coal, and should serve all tracks both inbound and outbound. The cinder pits should have sufficient capacity to accommodate all cinders received for a twenty-four-hour period if necessary, in case of emergency.

In some cases, additional facilities such as inspection pits, located in the vicinity of the inbound storage space, and mechanical engine washing apparatus, located between the cinder pit and turntable, are installed.

The inspection pit is for the purpose of making preliminary inspection of the engine both outside and underneath, to determine the nature of the repair work required, in which case work slips are forwarded to the roundhouse foreman prior to the engine arriving in the house, thereby allowing the roundhouse organization advance notice of the work to be done and giving them an opportunity to prepare for handling the work. At times minor repairs are made to the engines while on inspection pit.

Roundhouses should have a sufficient number of stalls to accommodate all engines from the time they leave the cinder pits until they are ready for service or called; they should also be of sufficient depth as to allow ample trucking space between the front of the engine and the outer wall, and good working space between the rear of the tender and the inner wall when doors are closed.

Drop pits or drop tables are recognized as essential in all roundhouses, in order to perform the necessary work on wheels and journal bearings.

Roundhouses should also have paved floors, being well heated and ventilated and designed to obtain a maximum amount of natural light.

A Measure That Saves Time

As a measure toward reducing the time required in handling an engine at the terminal and also to effect a saving in fuel, water and boiler repairs, a hot water boiler washing and refilling system should be installed in conjunction with the roundhouse.

The ratio of the number of stalls required to the number of engines handled in twenty-four hours is influenced greatly by various conditions, such as the class of power handled, the kind of work to be done, climate, uniformity during the twenty-four hours of receiving and dispatching power, and location with respect as to whether the terminal is at the end of the line or situated at an intermediate point. A ratio of two engines to one stall has been found to be a good working basis in most cases; however, the above conditions result in ratios as low as 1½ to 1, and as high as 5 to 1.

Shop buildings, supply buildings and miscellaneous buildings should be grouped in as close proximity to the roundhouse as possible without hampering freedom of intercommunication and handling of material. The size of various shop buildings and equipment to be provided is entirely dependent on the number of engines to be handled, the class of power and the class of repairs to be made.

Round or part roundhouses are used almost exclusively, except in cases of very small terminals handling only a few engines in twenty-four hours, in which cases long rectangular houses, with rails and pits placed parallel to the long side of the building are constructed. No short houses with rails and pits placed parallel with the short sides of the building are used.

Monitor Type Roof Favored

The prevailing type of roundhouse roof is the mill construction or slow burning roof, with beams of twelve inches by sixteen inches supporting 1½ to 2-inch matched boards six to eight inches wide, which in turn are covered by prepared roofing paper, tar and gravel. The design is usually of the monitor type with side lights in the vertical portion. In some cases these side lights are continuous sash around the house, while in others, windows and louvres alternate. Windows are of the pivoted type, operated from the floor. In order to provide the maximum natural lighting in roundhouses, 58 per cent of the outer wall area should be of glass and where design of doors on the inner circle permit, windows should be installed in the upper portion of the door.

Roundhouses of reinforced concrete construction, or brick and concrete construction, have ribbed concrete slabs with terra cotta tile between the ribs to eliminate condensation. These concrete slabs are covered with five-ply water-proof roofing paper.

Smoke jacks constructed of cast iron, transite, wood and wood lined with transite are all in use, with cast iron and transite jacks predominating. Cast iron jacks indicate the longest life, but are heavier, requiring stronger roof construction to support them. Smoke jack stacks range in sizes from thirty-six inches square to forty-two inches square, thirty-six inches round to forty inches round and twenty-four by forty-seven inches oval, the variation being due to the size of engines handled. The size of smoke jack hoods is uniformly four feet wide, but lengths vary from nine feet to fourteen feet. The use of dampers in smoke jacks is very limited, the only installations noted being in territory having very severe winter weather.

Ventilation in roundhouses is generally obtained by means of louvres and swinging window sash in the sides of the roof monitor. Other methods of ventilation comprise of square louvre monitors built around each smoke jack and round ventilators placed at the high point of the roof over each stall.

Doors Are in Four Groups

Doors on roundhouses may be divided into four general groups and described as the double swinging door, sliding folding door, rolling shutter door and the pneumatic lift door, but the double swinging door is the one most widely used. This type of door is constructed in some cases entirely of wood and in other cases of steel frame and wood, being approximately seven feet wide and sixteen feet high, with windows in the upper panels. They are hung on heavy pintles fastened to the building column, two doors being provided on each stall. The types of floor in most general use are:

First—Wood block floor;
Second—Concrete;
Third—Vitrified brick
Fourth—Mastic or asphalt.

The wood block floor has gained in general favor in late years on account of the ease on the feet of the workmen, the low cost of maintenance, the smooth trucking surface it affords, its ability to withstand shocks due to heavy pieces falling on it, and the less liability of damage to the pieces themselves. The material used is yellow pine, thoroughly impregnated with creosote and laid with the grain vertical on a 4-inch concrete base with pitch filler between the blocks and concrete. After blocks are laid they are flushed with hot pitch to fill all joints and cracks and make the floor waterproof.

Both the concrete and brick floors, while presenting good trucking surface, have the disadvantage of being cold and hard on the feet of the workmen, of easily chipping and cracking and wearing unevenly.

The mastic and asphalt floor laid on a concrete base is a satisfactory floor as it is less tiresome to work on than the hard concrete and brick floors and does not chip, crack or spawl off. The principal objection to this type of floor is due to the fact that it is difficult to repair on account of the special machinery necessary to mix and lay it properly. The initial cost is also higher than the other types of floors.

Engine Pits Are of Concrete

The present day practice in engine pit construction is to build them of concrete with side walls of sufficient thickness to give proper bearing for hydraulic jacks, used in jacking up engines. In some cases these walls are built the full thickness the entire length of pit, while in other cases the increased thickness for jacking purposes extends only a distance of from ten to twelve feet in length at each end of the pit. If there is considerable difference in the size of power handled, it is advisable to maintain the full thickness required for jacking the entire length of the pit. The floor of the engine pit should be crowned from center to sides and have a gentle slope from the front to the rear.

A small drainage pit covered by an iron grating is located at the low end. These drainage pits in each engine pit are connected together by 6 or 8-inch tile and at suitable intervals of seven or eight stalls drains are run to catch basins outside of the house, which in turn drain to the main sewer system.

Engine pits generally adhere very closely to the following dimensions: Width, four feet; depth, high end, two feet six inches; low end, three feet; length to suit depth of roundhouse.

At practically all terminals of importance artificial lighting is obtained by means of electricity, and for the general inspection of the outside of engines in the roundhouse the general house illumination augmented by the use of extension cord lights and hand flash lights is sufficient. Lamps on extension cord lights are protected by a substantial wire guard.

Lighting at Inspection Pits

For the inspection of engines are inspection pits located outside of the house a good arrangement consists of a row of five 200-watt lamps spaced twelve feet apart on each side of the pit and placed about 15 feet high with shallow dome reflectors; also two 50-watt flood lights, one at each end of the pit under the engine.

Illumination for repairs to engines is also taken care of by the general house illumination and the use of extension cord lights, flash lights and oil torches for cab, fire box, pit and boiler work. General house and yard lighting furnishes sufficient illumination for cleaning engines.

The latest systems for general illumination in engine houses consist of rows of drop lights in shallow dome reflectors between each stall, or flood lights placed on outer end near walls, or a combination of both. Where drop lights are used, a 500-watt lamp is located half way between the outer wall and the first building column or post, 250-watt lamps spaced centrally between the intermediate columns and a 150-watt lamp between the inner wall and the last column. In cases where flood lights are used, two lights are usually placed on the outer wall between each pit and one on the inner wall. Lamps varying in size from 100 watts to 300 watts are used in the flood lights, which are mounted eight to ten feet above the floor. In some instances drop lights are placed between the intermediate columns in addition to the flood lights, while in other instances angle metal enameled reflectors are placed on intermediate columns sixteen to twenty feet above the floor, with the light directed downward at an angle of 45 degrees.

The latest method of yard lighting at terminals is almost entirely by the use of flood lights placed on the coaling station, roundhouse roof, water tanks, or on steel columns. Flood lights in terminal yards should be located so as to obtain light from two directions or opposite directions, in order that clouds of steam or smoke will not shut off the illumination from any portion of the yard. Thousand watt lamps are generally used in yard flood lights and the number of lights required is dependent on the density of light desired on the area to be covered.

Heating by Direct Radiation

The most satisfactory method of heating roundhouses is by means of the hot air blast system, but for economy in first cost, houses of five stalls or less are usually heated by means of direct radiation. In the latter case, radiators are placed on the outer wall and on the sides of the engine pits. Cast iron radiation is usually used on the walls and either cast iron or pipe coils in the pits. The use of pipe coils in the pits meets with considerable favor on account of being able to withstand greater shocks and rougher usage than cast iron.

Hot blast installations in larger engine houses consist of the heater and blower fan equipment usually located in a separate room built on the outer circle of the engine house, a main concrete duct extending around the outer circle of the house, branch ducts of tile running to the engine pits and cast iron outlets along the outer wall connected direct to the main duct. The heater unit consists of a bank of cast iron radiation encased in a sheet steel house, so arranged as to take air either from the inside of the engine house or from the outside of the house. The fan is generally of the steel plate type, steel encased and driven by simple horizontal steam engine. The outlet of ducts to the engine pits are twelve inches in diameter, there being three outlets to each pit. In modern practice, the engine house is divided by fire walls, into sections of about twelve stalls to a section, with a separate heating unit for each section.

The advantage of the hot blast system are improved ventilation, occasioned by complete changes of air, uniform heat, low maintenance cost, ease of control and accessibility of locating leaks and making repairs.

The form of dispatch board most generally used in roundhouses is the plain black board, ruled horizontally and vertically. The vertical columns show the train number, date, engine number, engineer's name, fireman's name and time of departure. All information is written on the board with chalk.

Other appurtenances of a similar nature used in roundhouses are work report boards, engine condition boards, inspection boards and ready track boards.

Material Handled by Machines

Various mechanical devices are used in roundhouses for handling material or heavy parts of engines such as:

First—Electric crane trucks;
Second—Overhead traveling cranes;
Third—Monorail trolleys;
Fourth—Jib and bracket cranes;
Fifth—Power trucks;
Sixth—Portable hand-operated cranes.

The electric crane truck is the most flexible device obtainable for roundhouse use and one that is capable of a wide range of work. Trucks of this nature have four rubber tired wheels, a platform for transporting material and a crane boom for handling the material on and off of the truck platform. The trucks are self-propelled by means of an electric motor, current being supplied by storage batteries mounted on the truck. The crane or boom is of sufficient length to reach to the center of the top of an engine, by means of which such parts as front end rings, front end doors, smoke stacks, bell and frame, dome caps, throttle boxes and stand pipes, turbo generators, etc., can be removed and applied; also such parts as steam chests, valves and covers, air pumps, air reservoirs, cross heads, guides, pistons, main and side rods and other similar heavy parts can be handled with ease for removal and replacement. The boom can be swung 90 degrees each way from its central position, or through an entire circle if so desired. Both the load and the boom are raised and lowered by power and the boom may be slewed by either hand or by power.

The fact that these cranes can pick up its load, transport the load on the platform to any part of the roundhouse or shops, and unload or place the parts carried direct in a machine, make this device particularly adaptable to roundhouse use. These cranes are usually rated with a hoisting capacity of 3,000 pounds at six to seven feet radius, with a platform carrying capacity also at 3,000 pounds.

Some roundhouses are designed with a long center bay in which an overhead traveling crane operates, usually of 10 ton capacity. Such installations are not very extensive.

Monorail trolleys equipped with 2 to 5-ton hoist are used to some extent. The trolley rail is located around the outer circle of the house with branches leading from it between the pits.

Bracket Cranes Are Used

Jib or bracket cranes attached to the building columns between pits are used to considerable extent; these cranes carry chain hoist from 500 to 2,000-lb. capacity and are of sufficient length to handle smoke stacks and other parts located near the front end of the engine.

Portable cranes are usually of the 3-wheel type, having a short crane boom mounted on a steel frame work for raising and lowering heavy parts, which is done by hand with a geared windlass.

The machine tool equipment installed in the terminal described, is as follows:

Machine Shop

1—90-inch driving wheel lathe.
1—54-inch truck wheel lathe.
1—600-ton driving wheel press.
1—Driving wheel axle journal truing lathe.
2—36-inch draw cut shapers.
1—54-inch vertical lathe.
1—36-inch vertical lathe.
1—36-inch driving box boring lathe.
1—84-guide bar grinder.
1—30-inch by 18-foot engine lathe.
1—24-inch by 10-foot engine lathe.
1—18-inch by 8-foot engine lathe.
2—11-inch by 6-foot bolt lathes.
1—18-inch turret brass lathe.
1—2¼-inch by 24-inch turret lathe.
1—3-inch by 36-inch turret lathe.
1—100-ton forcing press.
2—60-inch radial drill presses.
1—36-inch vertical drill press.
1—20-inch vertical drill press.
1—24-inch crank shaper.
1—No. 5 Knee type horizontal milling machine.
1—Combination link grinder.

1—1½-inch double bolt cutter.
1—2½-inch double bolt cutter.
6—18-inch by 3-inch double floor grinders; from four to be located in roundhouse, one in each section and two in machine shop.

Tool Room

1—18-inch by 10-foot tool lathe.
1—20-inch crank shaper.
1—20-inch vertical drill.
1—Universal cutter and reamer grinder.
1—Twist drill grinder.
1—Floor stand tool grinder.

Boiler Shop

1—Heavy double end punch and shear.
1—60-inch radial drill.
1—Staybolt threading machine.
1—Staybolt drilling machine.
1—7-foot by ⅜-inch bending rolls.
1—Flanging machine.
1—Flange clamp.

Blacksmith Shop

1—2,500-pound steam hammer and furnace.
1—500-pound power hammer.
1—4-inch bar shear.
3—Forges.
1—1-tool furnace.

This equipment to be arranged for individual motor drive and is for the purpose of handling heavy running repairs.

At terminals where it is not desired to perform work of this heavy nature, the machine tool equipment recommended is as follows:

1—36-inch by 12-foot engine lathe.
1—24-inch by 10-foot engine lathe.
1—16-inch by 8-foot engine lathe.
1—14-inch portable engine lathe.
1—18-inch by 3-inch double floor grinder.
1—36-inch draw cut shaper.
1—1½-inch double bolt cutter.
1—100-ton forcing press.
1—42-inch boring mill.
1—16-inch upright drill.
1—36-inch upright drill.
1—60-inch radial drill.
1—24-inch by 36-inch double end punch and shear.
1—100-pound steam hammer.
2—Blacksmith forges.
1—Acetylene welding and cutting outfit.
1—Electric welding outfit.

The proximity of a locomotive terminal to large repair shops would have considerable bearing on the equipment to be provided.

In regard to the handling of oils and lubricants at mechanical terminals, it is recommended practice to store these in the general storehouse, either in a fireproof room or in a separate building.

How Oil Is Handled

Oil storage tanks are placed in a concrete basement and are filled by gravity flow from oil tank cars located on a track adjacent to the building by means of pipe lines extending from the oil tanks to the outside of the building.

Oil is elevated from storage tanks to delivery room floor by means of self-measuring oil pumps. Oil is delivered to engine men's supply building by Store Department on requisition made out by roundhouse foreman. Oil and lubricants are disbursed to engines by attendant in supply building and placed on engine by special attendant. Oil is measured either by self-measuring pumps or with standard measures and record maintained of all oil, lubricants or other supplies placed on each engine.

A separate building usually placed adjacent to the outbound track is provided for storing engine men's tool boxes, picks, shovels, oil cans, lanterns, torches and any other equipment or supplies engine men may carry on the engine. These tools and equipment are assigned to engine crews and are removed from engine on arrival at the terminal and placed on engine before departure from the terminal by engine hostler. A special attendant is in charge of this building at all times, who cleans and fills oil cans, lanterns and torches, and issues the oil, lubricants and supplies.

Provision is made at all terminals for wash, locker, toilet and rest room facilities for engine men. Separate buildings are sometimes constructed for this purpose, while at other times space is allotted in other buildings. Locker rooms are equipped with individual steel lockers, which are supplied with locks and keys, each man being assigned a locker. No particular arrangement is ever made for drying clothes.

For Comfort of Employes

Wash rooms are equipped with individual wash basins of sufficient number to accommodate the maximum number of men congregating at any one time; this is also true of the toilet facilities installed. Shower baths are also provided and hot and cold water is supplied, as well as ice water for drinking purposes.

At all terminals where engine men lay over, rest rooms containing sanitary steel bunks and mattresses are provided, but engine men furnish their own bed clothing. At large terminals, a room containing a long table and chairs for lounging and reading purposes are available, which constitutes the extent of recreation conveniences.

No provisions are made by the railroads for eating rooms or for cooking meals. At points where hotels or eating rooms are operated by railroad companies, or where railroad clubs or organizations are maintained, special rates are made to railroad men, whereby they obtain meals and sleeping accommodations at a nominal or actual cost charge.

Only a few roads in this country have adopted the practice of providing outside inspection pits at locomotive terminals, but where they are used, are so located on the inbound tracks as to be the first engine house facility reached by the engine on entering the terminal. Engineers leave engines at this point after making inspection. The roundhouse inspector makes a thorough inspection of engine while on the inspection pit and prepares work report. Engineer's and inspector's reports are given to roundhouse foreman, who arranges for the necessary work to be done on the engine when it arrives in the house. Tools and supplies are removed from the engine while at the inspection pit. Limited repairs are sometimes made, such as renewing minor parts, tightening loose bolts, applying keys or pins and such work or tests as will not hinder the prompt handling of other engines.

The hostler takes the engine from the inspection pit and after providing it with water, coal and sand, moves it to the cinder pit where fires are cleaned and ash pans emptied. When further inspection of engine is necessary, it is done while engine is at the cinder pit.

At terminals not having inspection pits, the handling of engines is practically the same, except the work and inspection at the inspection pit are omitted and inspection is either made in the yard or after the engine reaches the roundhouse. Inasmuch as all roundhouses are equipped with inspection pits, better inspection can be made in the house, as better protection from the weather is afforded.

Drop Pit Jacks Widely Used

Installations of both drop pit jacks and drop pit tables are prevalent throughout the country, although the former is used more extensively. The ram drop pit jacks are of the hydraulic, hydro-pneumatic and pneumatic types, the former being most favored, while the others follow in the order named. The ram type drop pit jack consists of a cylinder and ram mounted vertically on a four-wheel carriage and running on a narrow gauge track in a pit underneath the engine tracks. There is also mounted on the carriage or truck, a reservoir and force pump which can be operated by hand or by air motor, which furnishes the pressure for operating the ram. The ram is equipped with a "V" shaped block on the upper end, which engages the axle at its middle point. The pit in which the jack operates extends radially around the house, serving as many engine pits or stalls as desired. A pair of mounted wheels may be lowered from under an engine by the jack, and wheels moved to an adjacent track and raised to the floor level for repairs.

Drop tables or platforms are operated both by means of hydraulic jacks and by screws. Where screws are used, electric motors supply the power. The handling of the wheels is the same as with the jack; drop tables can be made into various sizes and do not require the careful spotting of the engine as is required with a ram jack; also tables can be made of such a size as to accommodate a four-wheel engine truck or a trailer truck.

The use of electricity is so extensive that the majority of engine houses are now equipped with electric lights and the extension cord light, supplemented by the pocket flash light, is used for inspection and examination of engines and boilers. The wick torch burning kerosene, is used where electricity is not available and by those who prefer it.

How Boilers Are Washed

The practice of washing boilers with hot water is used almost exclusively in this country in some form or other. The system designed for this purpose and used most generally consists of two large storage tanks of either steel or wood construction and ranging in capacity from 10,000 to 25,000 gallons each. One tank is known as the "Washout Tank" and the other as the "Refill Tank."

Two pumps are provided, one drawing water from the washout tank and one from the refill tank. Pumps discharge into separate mains which are carried overhead throughout the entire length of the roundhouse. Branch lines or drops are run down the building columns between pits, provision being made on these drops for valves and connections for attaching hose used in washing out and filling up boilers.

A third overhead main with drops between the stalls also extends around the full length of the house, through which the blown-off water and steam is carried from the boiler when connection is made between the drop and the blow-off cock on the engine. This main leads to the storage tanks, first passing through a sludge tank where the sediment in the water is deposited. The blown-off water and steam then passes through a separator where the steam disengages from the water, the steam passing into the refill tank where it heats clean, fresh water for refilling the boiler, while the blown-off water flows into the washout tank for use in washing out the boiler blown down.

The pressure used in washing out and refilling is 100 pounds per square inch. The temperature of the washout water is automatically maintained at approximately 130 degrees by tempering with cold water controlled by a thermostatic valve. The temperature of the refill water ranges from 180 to 200 degrees. The entire time consumed in blowing down, washing out and refilling a boiler averages from three and one-half to four hours.

Advantages of Hot Water

The advantages derived from the use of hot water for washing boilers, are as follows:

First—Elimination of the danger of damage to sheets of the boiler and fire box, as the use of cold water for this purpose results in cracked sheets due to sudden contraction;

Second—Reduction in time required for turning engines;

Third—Saving in fuel in firing up engines;

Fourth—Saving in water by conserving blown-off water from the boiler and re-using it for washing out the boiler.

In regard to removing scale not removed by washing out, the only mechanical method employed is by hammering or vibrating sheets by means of an air hammer equipped with a blunt nose tool. Also, when fire boxes are equipped with circulating tubes, turbine cleaners are employed for the purpose of removing scale.

The general practice of removing scale from flues is to do this work when engines are in the shop for general repairs, which work is done by flue cleaners. This operation consists of placing flues in a steel plate cylinder which is slowly revolved, causing flues to roll over and drop on each other until the scale is hammered loose and knocked off.

In removing soot from flues, compressed air at 100-pound pressure is generally used by attaching an air hose to a long piece of ½ or ¾-inch pipe having one end tapered to form a nozzle; this pipe is run through the flues from the fire box and forces the soot out ahead of it into the smoke box.

On superheater tubes and flues which have become honeycombed or clogged with cinders, iron rods having a hook on the end are first used to loosen the clinker deposit before flues are blown. In some cases steam jets are used instead of compressed air.

Firing Up and Avoiding Smoke

The most general method of firing up engines is by means of wood and coal. Scrap wood from car repair tracks and slab wood and refuse from lumber mills are used; shavings from the car department wood mill are also used when available. A bed of wood is first placed over the grates and a thin layer of coal placed over the wood. Wood is ignited by pieces of oil soaked waste thrown in the fire box and additional coal is added as needed.

Another method employed is to place a bed of coal from two to four inches deep over the grates and then spray it with crude oil by means of air or steam jets, after which it is ignited by means of lighted waste. A few cases are reported where a crude oil burner is used to play a flame over the coal until it ignites. In all cases steam pressure from the roundhouse blower line is used to create draft in the fire box until sufficient steam pressure is available in the boiler to use the engine blower.

There are very few installations in this country for collecting smoke emitted from smoke stacks by mechanical means, and these only occur where roundhouses are located in thickly populated districts and municipal ordinances require such a device.

Smoke Collectors

A typical installation of this kind consists in providing upright standpipes between alternate stalls, with a wye branch connection at the top, extending to each side of the adjacent track. The ends of the branch pipes are fitted with a flexible telescopic connection which fits over the smoke stack; the stand pipes are connected to an underground concrete duct running around the circle of the house. The smoke and gases are drawn off by means of a large exhaust fan, which in turn discharges into a brick chimney; the smoke thus drawn off becomes diluted with air and when it emerges from the stack, has a grayish color, which is not offensive to the immediate community. This arrangement is varied in some cases by placing the duct overhead and using straight telescopic jacks to connect to the locomotive stacks. When smoke ducts are placed overhead, transite board is used in the construction. Another installation on record consists in collecting the smoke through jacks and ducts as described above, but instead of discharging gases direct into a chimney, they are passed through a body of water and washed, removing the fine particles of carbon. This particular installation serves a 30-stall roundhouse, the main duct being three feet in diameter at the small end and six feet in diameter at the fan inlet. The discharge is through three branch ducts, each leading to a separate water compartment and so designed that smoke enters the water at a low velocity. The water compartments are eight feet wide by twenty feet long and the depth of water through which the smoke passes is about fourteen inches. Each compartment has a canopy over it, which in turn is connected to one common stack. A 78-inch steel plate fan driven by 300 horse power electric motor, capable of handling 68,000 cubic feet of gas per minute, at a temperature of 500 degrees and at a static pressure of fourteen inches of water at the fan inlet, is used.

All modern coaling stations are of the mechanical type, constructed of reinforced concrete. In this type of coaling station coal is dropped from dump bottom or hopper bottom coal cars into an underground concrete hopper, from which it is fed through a coal crusher to the elevating machinery, which consists of either a continuous bucket conveyor or skip hoist buckets, so arranged that one ascends as the other descends. Coal is discharged from the conveyors into overhead storage bins, from which it flows by gravity through spouts or aprons to the locomotive tenders. Coaling stations of this type can be equipped with an automatic weighing device if so desired.

Coaling Facilities

The capacity of a coaling station is determined by the number of engines handled in twenty-four hours, the practice being to provide overhead bin storage capacity that sufficient coal may be elevated in eight hours to last the balance of the 24-hour period.

At small terminals, locomotive cranes equipped with clam shell buckets are used very extensively, loading coal directly on engine tender from coal cars or from coal storage docks.

Some coaling stations are equipped with automatic weighing devices for ascertaining the amount of coal placed on the locomotive tender, but the application is not general. The most common method employed is to estimate the amount of coal taken, based on the known capacity of the tender. Coal slips are issued against each individual engine and record kept of the amount of coal each engine uses. At regular intervals a check is made of the total amount of coal disbursed as against the total amount received at the coaling station and proper adjustment made in the records. These records are used in determining the engine men's fuel performance; are furnished fuel supervisors in each district to find cause of irregularities in fuel performance and make necessary corrections; and for various statistical purposes, such as tons used per locomotive mile, tons used per 100 passenger car miles and tons used per 1,000 gross ton miles.

Coal for Firing by Stoker

Various practices prevail in regard to the preparation of coal for stoker fired engines. A great many roads use the regular run of mine grade of coal on the tender and depend on the crusher on the tender to crush coal to proper size for the stoker. In other cases breaker bars are placed over the coal hopper at the coaling station by means of which the larger lumps are broken up. In a great many instances crushers are installed in the coaling stations, while a still different method provides for the installation of screens in the top of the coaling station which separate the smaller size lumps of coal from the large lumps, and by means of chutes, divert the coal passing through the screens to a bin for serving stoker fire engines, and the coal passing over the screens to a bin for serving the hand fired engines. Another practice adopted is to purchase coal properly prepared direct from the coal mines.

Ashes are removed from fire boxes by shaking the grates either by hand or by power grate shakers when engines are so equipped. A number of railroads make use of a dump grate to permit easier handling of clinkers, but when all grates are of the rocking type a slash bar is used to break up the clinkers and force them through the grates. In cases where very bad clinkers are encountered which cannot be broken in this manner, they are drawn through the fire door with a hook. All engines are equipped with a self-cleaning type of ash pan which relieve themselves of most of the accumulation of ash and clinkers when the hopper door or slide is open. The sides and corners of ash pans where ashes are likely to lodge are washed down with water, or are cleaned by means of a steam or air jet. Ashes from ash pans are dropped direct into cinder pits or into cinder handling apparatus.

Types of Cinder Pits

The most general type of cinder pit is the deep water pit. These pits usually average eight feet deep by fourteen feet wide and range in length from forty-five feet, for serving one engine, to 300 feet, capable of accommodating four engines at a time. Cinders are removed from the short ash pit by locomotive cranes equipped with clam shell buckets and in the case of long pits by either overhead traveling cranes or gantry cranes, equipped with clam shell buckets. These cranes load the cinders direct into cinder cars which are placed on an adjacent track. At locomotive terminals having two inbound tracks, these pits are made double and cinder car track is placed between the inbound leads. The long deep water pit provides large storage capacity, which is a decided advantage, especially at terminals where there are periods during the day when a large number of engines arrive in a short period of time and must be handled rapidly.

At small terminals, patented mechanical devices are quite extensively used to advantage. Such devices consist generally of a sheet iron buggy of approximately one yard capacity mounted on flange wheels and operating on an incline track to a sufficient height to unload its contents by dumping into a cinder car. A concrete pit open on one side is built under the inbound engine lead and a cinder buggy stands in this pit to receive ashes from the locomotive ash pan. When buggy is filled it is drawn up the incline track by means of a steel cable, attached in some cases to an air hoist and in others to a cable drum operated by an electric motor. When it reaches the highest position on the incline, the buggy automatically stops, trips and discharges its load, after which it returns to its normal position in the pit.

All railroads dispose of their cinders for filling-in purposes, or for surfacing yards and tracks.

Locomotive design in this country provides for self-cleaning front ends, the arrangement in the smoke box being such that the draft created by the exhaust from the cylinders carries cinders up and discharges them from the smoke stack. With the old style cinder hopper located on the bottom of the smoke box, which is now practically obsolete, the front ends were usually cleaned when engines were on the cinder pit by operating the slide in the cinder hopper and using the cleanout hole in the side of the smoke box for the purpose of pushing cinders down through the cinder chute.

There is no system in use in this country for the recovery of coal or coke from cinders and no railroad making a practice of separating ashes from the smoke fox, from those from the fire box.

Storing and Supplying Sand

Sanding facilities are usually provided in connection with the coaling station and consist of an overhead dry sand storage bin located in the coaling station structure, a sand drying house and equipment, and a wet sand storage bin; the two latter facilities located on the ground in close proximity to the coaling station.

Two general methods of drying sand are in effect, viz.: the coal burning stove and the steam coil.

In the first case, a pot or egg shaped stove is used around which is placed a sheet steel hopper having an opening around the stove at the bottom. This hopper is filled with wet sand which falls to the floor through the bottom opening as it dries. In the case of steam coil, the arrangement usually consists of a sheet steel box, open on the top and bottom. On the bottom side are placed two rows of steam pipes which are staggered to prevent a direct vertical opening between the pipes. The box is filled with wet sand which passes between the pipes as it dries, dropping to the floor. Incline screens of 3-inch by 4-inch mesh with gravel box at the bottom are used for screening the sand, which is shoveled from the floor around the sand dryer on to the screen. The dry screened sand falls into a drum, from which it is forced by air to the elevated storage bin in the coaling station, from where it is delivered to engines by gravity through suitable spouts. A wet sand storage bin is always provided in connection with a sand drying house and in cold climates these bins are usually covered and of sufficient capacity to store a winter's supply.

Installations for Water Supply

Very few instances are encountered where cold water lines are installed in roundhouses for filling tenders, the general practice being that in cases of emergency, tenders are filled through the manhole from the fire lines.

The treatment of water for locomotive boiler use is continually becoming more general and at the present time is quite extensive through bad water districts in the country. The most general method used consists of the installation of water treating or water softening plants, using the soda-ash and lime treatment. These plants are of the intermittent and continuous type; the former being used where the consumption of water is not very great. This type consists generally of two vertical tanks in which chemicals are introduced to the water, which is agitated by mechanical means for a certain length of time to insure complete mixture and then allowed to settle until precipitation has been completed. The treated water is then drawn off as needed and the sludge and sediment collected, blown off. Tanks are operated alternately, the water being treated in one while the treated water is being drawn off in the other. In the continuous type, which is used where there is a large demand for water, the water being treated flows continuously through the system. These installations in addition to having two large vertical tanks, are equipped with filters, using either sand and gravel, or excelsior. The first tank is divided into two compartments with an opening in the dividing partition at the bottom. The chemicals are supplied to the incoming water through the mixing box located at the top of the first water compartment; this water passes downward through the first chamber through the opening in the partition at the bottom, and upward through the second chamber, from which it passes to the second vertical or storage tank. The movement of this water is very slow and a large portion of the precipitation caused by the injection of the chemicals settles to the bottom of the first tank. Additional collection of sediment is accomplished in the storage tank and in the filters, from which the treated water is pumped to the wayside tanks for use of the locomotives.

Where installations of this extensive nature are not used, a supply of prepared boiler compounds is carried on the engine and at the roundhouse, and the required amount placed in the cistern of the tank at each filling. The amount of compound required being previously determined by analysis of the water used.

The general practice is to install facilities which will enable treating of water used to the extent that the amount of incrusting solids remaining in the water after treatment will range from two and one-half to four grains per gallon.

A typical analysis of water treated in this manner, is as follows:

	Raw	Treated
Oxid of iron	0.05	0.00
Calcium carbonate	20.60	1.40
Magnesium carbonate	0.34	Trace
Magnesium sulphate	13.00	0.00
Incrusting solids	33.99	3.00
Sodium hydroxide	0.00	1.30
Alkali carbonates	0.00	1.00
Alkali sulphates	0.00	14.70
Alkali chlorides	4.80	4.80
Organics undetermined	0.21	4.80
Non-incrusting solids	5.01	21.80
Total solids	39.00	24.80

The two practices in effect for cleaning engines are the hand wiping method and that of cleaning by mechanical means. The first or hand wiping method whereby all parts of the engine, except the front end or smoke box and the outside casing sheets below the running board, are wiped by hand with waste and oil, is the one most generally employed. This also includes the tender cistern. The second method consists of washing the engine with a mixture of hot water and oil applied with air pressure at about 100 pounds.

A combination of the above two methods has been adopted by some roads, which consists of washing all parts below the running board and hand wiping with waste and oil those parts above the running board.

Installation for Turning Engines

The deck girder balanced type turntable with deep pit is the installation most frequently encountered in this country on account of being more rigid. Where tide water or poor drainage conditions exist, the through girder balanced type with shallow pit is used.

In recent years a design of turntable has been developed which is known as the three-point twin span table. This type of table is so designed that a portion of the weight of the engine is distributed to the end bearings so that the total weight is distributed over three points. This table is used to some extent, particularly where engines of extreme lengths are handled. Tables for handling modern engines range in length from eighty-five to 120 feet and are turned by power driven tractors.

Ten-Coupled Switching Locomotive for the Newburgh & South Shore Ry.

The Newburgh & South Shore Ry. operates a general switching and transfer service in the industrial section of the Cleveland district. The road has in operation, Baldwin locomotives of the 0-6-0, 2-6-0 and 0-8-0 types, which are equipped with superheaters and have an average load of 55,000 to 60,000 pounds per pair of driving wheels. The latest addition to the motive power equipment is a ten-coupled (0-10-0 type) switching and transfer locomotive, which has an average load per pair of drivers of 58,600 pounds and exerts a tractive force of 68,850 pounds. A comparison of the principal dimensions of this locomotive with those of the heavy 0-6-0 and 0-8-0 types previously built, is of interest, and is given in the following table:

Ten-Coupled Switching Locomotive for the Newburgh & South Shore Railway

Type	Cylinders	Drivers	Steam pressure	Grate area	Water heating surface	Super-heating surface	Weight, total engine	Tractive force
0- 6-0	22"x28"	52"	190	38.9	2,196	505	178,000	42,090
0- 8-0	24"x30"	54"	180	62.7	2,843	614	221,700	49,000
0-10-0	27"x30"	54"	200	70.2	4,084	993	293,000	68,850

As compared with the 0-6-0 and 0-8-0 types, the 0-10-0 type locomotive shows an increase in weight of 64 and 32 per cent, and in tractive force of 63 and 40 per cent, respectively.

The new locomotive is designed for service on curves of 20 degrees, and grades of 60 feet per mile. It has a rigid wheel base of 20 feet, with all tires flanged except those of the middle (main) pair of drivers. The driving tires are of vanadium steel, a material which is used for the spring hangers also. All holes in the spring rigging subject to wear, are fitted with hardened bushings.

The valve gear is of the Walschaert type, and the valves are set with a maximum travel of 6½ inches and a lead of ⅛ in. They have a steam lap of one inch, but no exhaust lap or clearance. A Ragonnet type "B" power reverse gear is applied.

The boiler is of the straight top type and it contains a brick arch and a superheater having 45 elements. There is a complete installation of flexible stay-bolts, with the exception of the ten central rows of crown stays. The throttle valve is equipped with an auxiliary drifting valve.

The tender has capacity for 9,000 gallons of water and 16 tons of coal. The frame is built-up with 12 inch channels for the longitudinal sills; and the trucks are of the arch-bar type, with cast steel bolsters.

The purchase of this large locomotive is in line with the policy of the Newburgh & South Shore to introduce heavier power as traffic requirements become more severe. The locomotive is an excellent example of modern design, and in service is giving most satisfactory results.

Further particulars of this locomotive is given in the accompanying table showing its weights and dimensions.

PRINCIPAL WEIGHTS AND DIMENSIONS.

Type	10 coupled (0-10-0)
Gauge	4 ft. 8½ in.
Cylinders	27 in. by 30 in.
Valves	Piston 14 in. diam.
Boiler:	
Type	Straight top
Diameter	86 in.
Steam pressure	200 lbs.
Fuel	Soft coal
Firebox:	
Material	Steel
Type	Stayed radial
Length	120 1/16 in.
Width	84¼ in.
Depth, front	79¾ in.
Depth, back	65½ in.
Grate area	70.2 sq. ft.
Tubes and flues:	
Tubes, number	262
diameter	2 in.
length	19 ft. 0 in.
Flues, number	45
diameter	5½ in.
length	19 ft. 0 in.
Heating surface:	
Firebox	236 sq. ft.
Tubes	3,821 sq. ft.
Firebrick tubes	27 sq. ft.
Total	4,084 sq. ft.
Superheater	993 sq. ft.
Driving wheels:	
Diameter, outside	54 in.
Diameter, center	46 in.
Journals, main	12½ by 13 in.
Journals, others	10 in. by 13 in.
Wheel base:	
Driving	20 ft. 0 in.
Rigid	20 ft. 0 in.
Total engine	20 ft. 0 in.
Total engine and tender	65 ft. 8½ in
Weight in working order:	
On driving wheels	293,000 lbs.
Total engine	293,000 lbs.
Total engine and tender	467,200 lbs
Tender:	
Wheels, number	Eight
Wheels, diameter	33 in
Journals	5½ in. by 10 in.
Water	9,000 U. S. gallons
Fuel	16 tons
Tractive force	68,850 lbs.
Service	Switching

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Comfort in the Roundhouse

An idea once extensively held was that a cold, uncomfortable shop in the winter was an incentive to extra exertion on the part of the men, in order to keep warm and so do more work. So that all fuel burned for warming purposes involved a double loss: the cost of the fuel and the labor lost because of the lack of the cold's incentive to endeavor. This discarded idea has been superseded by the one that advocates comfort as an incentive to endeavor.

If comfort is an incentive to endeavor then there is much room for the development of that incentive in the average roundhouse. And it is not so many years since the first steps were taken in that direction. The old cast iron stove, heated to redness and sending out its volumes of heat to be dissipated through the ventilators into the atmosphere, served as a gathering point for the men, while the surrounding chill and smoke made roundhouse work a job to be dreaded and avoided. The smokejack never carried off all the smoke and the noise of the blowers made shouting a necessary concomitant of conversation.

These conditions were accepted as inevitable and unavoidable so that they were accepted as a matter of course and complaints were few.

It seems strange, however, that with the example of the city fire engine before them wherein a steam pressure was maintained day and night by an attachment to a stationary boiler, should have failed to have attracted the attention of railroad men as a means of lessening the smoke nuisance in the roundhouse by making it possible to do away with fires, and increasing the temperature in winter to the point of comfort by making it possible to close the ventilators and smokejacks. And, by so doing, incidentally increase the efficiency of the house forces.

It is possible too that this efficiency might be still further increased by the elimination of the noise of the stack blowers, but of this more in another place at another time. It suffices for the present to present the desirability of increasing the comfort by increasing the temperature in cold weather and decreasing or doing away altogether with the smoke.

In a report before the recent Smoke Prevention Association Mr. L. G. Plant presented a paper on a fireless steaming system for engine terminals, which is based on essentially the old method of fireless steaming of fire engines that so effectively avoided the generation of smoke in their houses, though somewhat different in the details of the appliances used for its application.

But while Mr. Plant stresses the desirability of eliminating the smokejack, escaping steam, and loss of heat through the roof openings he is strangely silent upon the direct gain due to a probable increase in the efficiency of the roundhouse forces, a gain which would probably more than equal the heat losses avoided and thus more than double the tangible and visible economies.

The proposition would seem to be too self evident to be worth advocating, and yet it is difficult sometimes to impress men with the costliness of discomfort.

The Mileage of Switching Locomotives

A good many years ago, longer than most of us can remember, someone made a guess that a switching locomotive would average about six miles an hour for the period that it was in service. This seemed such a reasonable figure and so much below what the engines were probably making that it was considered a conservative basis for the erection of statistics of locomotive costs and was adopted. Some master mechanics, for they were all master mechanics who had charge of the locomotives in those days, were rather dissatisfied with this speed as not giving the switching locomotive credit for all of the mileage that it was actually making. But they had no figures on which to base a demand for a higher rating and so the guess that the switching locomotive traveled throughout the day at a pace about equal to that of old Dobbin jogging along a country road, stood and still stands.

And if long establishment is any argument for the continuance of a practice, then certainly this rating of six miles an hour as the credit for switching service, should be allowed to remain undisturbed, for we have based our statistics upon it now for pretty close on to fifty years. It seems to be a replica of the laws of the Medes and Persians that were reputed to be without change.

It must have been about twenty years ago that the first rude shock was delivered to this comfortable guess. A committee was appointed by the Master Mechanics' Association to consider and report on the mileage of switching engines and their ratings.

At the first meeting of that committee, one skeptical member asked as to what mileage the switching locomotives really made and there was no one there who could answer the question. He then proposed to find out and was detailed to do it. So arrangements were made to attach revolution counters to the driving wheels of a number of switching locomotives and find out as to exactly what they did do. The first engine equipped was in the Norwich yards of the New York, Ontario and Western and the recording of the revolutions was placed in the care of a responsible man; but when he reported an average speed of less than two and a half miles an hour on a two week's service, the record was suppressed for the time being, as being absurdly low. Then the committee member took charge of the matter in person, and to his astonishment he failed in every case to get a speed of three miles an hour. In one case it dropped as low and about two and one-eighth miles.

Of course there was nothing to do but report the facts, and recommend that the rating of switching locomotives be lowered.

Then there happed a curious thing. The ostrich has been erroneously reported as being so foolish that it will hide its head in the sand in order to conceal its body. And so the Master Mechanics' Association, in emulation of the reputedly foolish ostrich, proceeded to do that very thing. The report was received with evident disapproval and, in the discussion of it, it was urged that it would never do to accept the recommendation of the committee because it would show the executive officers that the members did not know what they were doing and besides it would so jump up the mileage cost of repairing switching locomotives, that it would be impossible to make an adequate explanation. And so the information that switching engines were not even keeping up with old Dobbin, or even with a brisk walker, was allowed to die and we have continued to use the six mile basis for our statistics.

It does not seem that at this day, when it is well known that switching service is the hardest to which a locomotive can be subjected, that there ought to be any hesitation about adopting a mileage rating that is more in accordance with what is being attained. There is no good reason why, because our predecessors stuck their heads in the sand, we should continue to do so, with everybody, who knows anything of the subject, laughing at us.

Naturally that old report aroused a good deal of skepticism, and several members went home and tried the thing for themselves. As far as published and private information goes, not one of them succeeded in getting as much as three miles an hour for their switching locomotives. So why call it six when we know that it is less than three?

It is all very well, that prohibition against removing of ancient landmarks, but when those landmarks are false guides and point away from the truth, it would seem to be just as well if they were to be removed and the guess of fifty years ago on which they were established forgotten.

A number of years ago in The Belle of New York, Dan Daly had a song that he sung as the leader of the cohorts from Cohoes. The refrain was: "Of course you can never be like us, but try to be as like us as you can." So now, though it may be quite impossible to adopt a mileage rating that will fit every case, or perhaps any case, we can, at least, follow Daly's injunction and adopt something that will be as near the truth as we can.

In another column attention is called to the low, or rather seemingly low mileage that has been made by the oil-electric locomotive, fathered by the Ingersoll-Rand, General Electric and American Locomotive companies. As a matter of fact it is not all low but quite up to the average, and in some cases, notably that of its work on the New Haven, it is well above that average.

Baiting the Railways

Notwithstanding the long deferred but much merited rebuke the anti-railway propagandists received at the polls last Fall, there are those in high office and others seeking election to the halls of Congress on a platform which in substance, if enforced, would seriously cripple, if not practically destroy the splendid transportation system on which this nation depends.

After the miserable failure of Government control to properly operate, organize or maintain our railways during the war, thus turning them back to their owners in a miserably run down, disorganized condition, it was doubtful if any one either in or seeking public office would have the temerity to advocate government ownership of railways.

It seems, however, that many who are clamoring the loudest for what they term reforms for the benefit of the "dear peepul," possess none of the essential elements of true statesmanship and care little or nothing for the people (except their vote) and are in fact politicians trying to either secure or hold on to a job supported by taxation. As one of the most successful means of vote getting has been baiting the railways, there are now and probably will continue to be in future a few who will continue to misrepresent matters and try to delude the people.

In all the public utterances of the anti-railway propagandist we never hear them even admit that in just a little over two years of Government control, many of our best railway systems were so shamefully mismanaged that now after about five years they have just about recovered the lost ground.

It is worthy of note that one of the largest transportation systems in the world with an operating ratio yielding a good surplus after all fixed charges, dividends, etc., was returned to its owners in a badly run down, disorganized condition and with an operating ratio of about 103 per cent.

Any one with just ordinary judgment well knows that even a rich corporation with millions of surplus, is, under the above conditions only a short distance from bankruptcy, yet there are those who clamor for the repeal of the Esch-Cummins Law and for Government ownership.

Since the return of our railways to their more than 800,000 owners, the officers have not only given the public far superior service but have rehabilitated both the physical properties and organization. Then again the American Railway Association through its wise policy and able officers, particularly its principal spokesman and president Mr. Aishton, have accomplished wonders, as it were, in the way of repairing past damage and bringing about a better understanding of the whole railway problem, particularly its relation to the welfare and prosperity of the country at large.

During the past 30 years the railways have no doubt made mistakes, but they have not only been pretty thoroughly regulated, but have also not been overlooked by the assessor as the accompanying lists of the costs of regulation and taxes paid bear most eloquent testimony.

In the first column below is shown, by years, what railway regulation has cost the people, while in the second column is shown by years what taxation has cost the railways.

Year	Annual Expenditures, I.C.C.	Taxes Paid By Railways
1888	$97,867	....
1889	149,453	$27,590,394
1890	180,440	31,207,469
1891	214,844	33,280,095
1892	221,745	34,053,495
1893	217,792	36,514,689
1894	209,250	38,125,274
1895	216,206	39,832,433
1896	234,941	39,970,791
1897	234,909	43,137,844
1898	237,358	43,828,224
1899	238,125	46,337,632
1900	243,624	48,332,273
1901	255,979	50,944,372

Year	Annual Expenditures, I.C.C.	Taxes Paid By Railways
1902	271,728	54,465,437
1903	298,842	57,849,569
1904	321,533	61,649,474
1905	330,739	63,474,679
1906	382,141	74,785,615
1907	538,827	80,312,375
1908	736,530	84,312,375
1909	988,936	90,529,014
1910	1,165,336	103,795,701
1911	1,290,978	108,309,512
1912	1,469,689	120,091,534
1913	1,560,404	127,331,960
1914	2,094,583	140,531,575
1915	3,933,926	139,298,167
1916	4,834,098	151,599,841
1917	5,182,169	219,973,127
1918	5,721,680	192,119,090
1919	....	198,567,954
1920	5,542,373	276,933,596
1921	6,193,714	286,213,871
1922	5,242,596	309,478,764
1923	5,295,444	340,632,054
Total	$61,817,324	$3,793,583,033

From the foregoing it will be noted that the cost of regulation to 1924 was $61,817,324 to which may be added about $98,775,522 expended by the railways and the Government on valuation work during the years 1913 to 1923 inclusive or a total of $160,592,846.

The amount of taxes paid by the railways 1889-1923 inclusive runs into the stupendous sum of $3,793,583,033 which amount at $80,000 per mile would build more than 47,000 miles of railway.

RAILWAY & LOCOMOTIVE ENGINEERING holds no brief for the railways, The American Railway Association or others interested in this great problem, aside from our declared purpose to aid at all times in constructive and not destructive plans, schemes, or other untried, doubtful, or fallacious theories.

The railways of this country represent property assets of upwards of $22,000,000,000 and had a gross income in 1923 of over $6,413,000,000 of which they paid out in expenses more than $5,391,000,000, $3,043,161,163 of this enormous sum went to 1,879,773 employees.

A business of such magnitude, supported by the people in the form of passenger and freight rates, calls for the highest grade of experienced men in its management and regulation. Those who may, as the result of political preferment, have a voice in either making laws or shaping the policy or interpretation of existing laws in dealing with this problem, will do well to heed the advice of those who have played prominent parts in the rehabilitation work of our railways, and turn a deaf ear to those who would jeopardize the interests of more than 850,000 shareholders and about 900,000 bondholders, or about 1,700,000 security holders, through a Government ownership scheme.

In addition to the foregoing evils such schemes would automatically transfer about 1,879,773 employees into some sort of a political machine where they would continually be subject to the entreaties, wiles or coercion of crafty political "vote getters" which alone would be destructive to the morale of any such organization.

There are now something like 20,000 miles of railways in the hands of our courts, and had it not been for the retention of the Esch-Cummins Law, and the defeat of the anti-railway propagandist, it is safe to predict that more than twice that amount of mileage would now be in the hands of receivers.

There are still better days ahead for our railways if regulation is on some equitable lines, administered as a successful business proposition should be, by experienced men of known integrity and not tinked with by professional politicians.

Economies Saved Two Million Tons of Fuel

More than $21,500,000 was saved by the Class I railroads on their fuel bill in the first five months of this year compared with the first five months of last year, according to official figures just made public by the Bureau of Statistics of the Interstate Commerce Commission.

The total cost of coal and fuel oil for the five months ending with May, 1924, was $160,251,665 as against a cost of $138,683,648 for the first five months of this year.

This saving resulted partly from a decrease in the price of coal and partly from savings effected by the railroad managements.

Owing to these economies the railroads consumed 14 less pounds of coal (including the equivalent coal tonnage for fuel oil used) per 1,000 gross freight ton-miles in the first five months of this year than in the corresponding period last year. In other words, this year the railroads were able to haul 1,000 tons of freight one mile on only 147 pounds of fuel compared with the 161 pounds needed during the same period last year. In this way they saved 2,003,841 tons of fuel.

$65,500,000 Saved Since 1920

This saving in tonnage is in addition to the 14,400,000 tons saved by the railroads between 1920 and 1924 inclusive. The $21,568,017 saved on the fuel bill of the first five months of this year is in addition to about $44,000,000 saved in the last four years. In other words, since 1920 the railroads have saved 16½ million tons of coal and over 65½ million dollars on their fuel bill. At the present rate of saving of this year it is probable that the roads will reach new marks in the economy of fuel.

In the Eastern District 959,236 tons of fuel were saved and 12 less pounds were consumed per 1,000 gross ton-miles.

In the Southern District 217,876 tons of fuel were saved and 15 less pounds were consumed per 1,000 gross ton-miles.

In the Western District 826,729 tons of fuel were saved and 14 less pounds were consumed per 1,000 gross ton-miles.

Notwithstanding this saving, the railroads increased the average number of cars per freight train from 40.4 in the first five months of 1924 to 42.6 in the first five months of this year and the net tons per train from 692 to 723. In spite of the heavier and longer trains the freight traffic of the country moved 0.5 of a mile faster this year than last.

In passenger service the saving of fuel consumed this year was 744,384 tons. This reflects a decrease of 1.1 pounds of fuel per passenger-train car-mile. Along with this went an increase in passenger-train car-miles of 10,532,000.

No business venture no matter whether it be a fruit stand on the street corner or a railway system can long endure, unless the income is sufficient to properly maintain the business in a good healthy condition as a going concern, and yield a reasonably fair profit to the investor.

Many of our railways, particularly in the northwest, have as the result of reduced income, barely escaped receivership. This condition it is hoped those in authority will extend adequate relief.

Working Capital Versus Idle Money or Frozen Accounts

Second Article

In the August issue we presented an article under the above title, in which attention was directed to a very important item of expense in railway operation, and which was calculated to effect a very substantial saving in the amount of capital tied up in material and supplies, and indirectly to improve the efficiency of the whole transportation unit.

We have received quite a number of responses to the article, both verbally and in writing, and while most of these are highly complimentary, even to the point of soliciting MORE LIGHT on this matter, the tenor of some would indicate that there are yet some doubting Thomases whose eyes or ears may have to be pried open with a crowbar before they will enjoy the effulgent rays of economic sunshine in which others are now basking.

To those who either doubt the possibilities of effecting great savings in this particular field, or who may think after gathering up one or two car loads of obsolete material that the job is complete, we wish to remind them of the fact that when Alexander the Great sat down and wept that there were no more worlds to conquer, the poor fellow had only scratched a little around the edges of the habitations of man, and he then proceeded to go on a big drunken debauch and killed himself celebrating what he thought was the accomplishment of a great achievement, which however, had in reality only been well started.

As indicative of the trend of thought on matters of this kind, the substance of certain comments, criticisms and inquiries may be of interest.

One railway officer says: "We were at first disposed to take umbrage at the general tenor of the article for the reason that we had been for a long time cutting down on requisitions and thought we were on thin ice, as it were, but since we have begun to dig into store rooms, cellars, yards, bins, stations, junctions, interchange points, offices, depots and office buildings and all other places where company property is kept, concealed and hidden, and where it rots, rusts or just dies (financially) of old age, we find so much of the company's funds tied up in this old junk that we are actually ashamed to admit it.

"A good old-fashioned house cleaning, however, will not only thaw out some frozen accounts and put a bit of idle money to work, but with certain articles or materials, no new purchases will be necessary for some time, and of course a no small amount of material and supplies, bought at market prices will find its way into scrap at so much per ton or, if possible, be written off the books as a total loss."

Another reader of good literature seemed a little doubtful as to any railway company having on hand as much as $20,000,000 of material and supplies, and suggested that $10,000,000 in material and supplies and $2,000,000 to $3,000,000 in cash was not only a whole lot of capital to have tied up, but approached pretty closely to the value of a medium sized railway, and was far in excess of the amount of capital invested in some of our largest industrial concerns.

W. E. Symons -- Sept. 1925.

Initial of Line (1923)	Average Mileage Operated	Investment in road and equipment (book value)	Cash, Material and Supplies, Amount Per Mile, Etc.					
			Cash	Material and Supplies	Total M. & S. & Cash	Aver. Per Mile	Per cent of investm't	Opt. Ratio (1923)
1 A. T. & S. F.	8,956	$786,527,018	$25,157,518	$28,550,547	$ 51,708,065	$ 5.773	$.0657	71.66
2 A. C. L.	4,860	225,972,920	12,205,195	9,259,393	21,464,588	4.416	.0949	74.02
3 B. & O.	5,303	767,692,447	13,722,296	23,365,627	37,087,903	6.995	.0483	77.98
4 Ches. & Ohio	2,552	321,907,452	5,411,615	10,840,335	16,251,950	6.760	.0504	77.36
5 C. & N. W.	8,462	484,888,748	22,055,633	14,847,279	36,902,912	4.360	.0761	82.60
6 C. B. & Q.	9,401	555,141,923	9,777,131	23,402,758	33,179,789	3.528	.0597	78.41
7 C. M. & St. P.	11,010	717,219,853	5,787,382	15,214,682	21,002,064	1.907	.0292	79.59
8 C. R. I. & P.	7,635	376,275,790	3,383,474	11,564,769	24,948,243	3.266	.0663	80.46
9 Del. & Hudson	894	120,730,077	3,128,258	4,128,001	7,258,259	8.116	.0600	83.14
10 Del. Lack. & West.	952	239,455,376	2,552,530	5,869,272	8,421,802	8.846	.0351	78.73
11 D. & R. G.	2,595	195,726,273	3,166,587	5,010,255	8,176,842	3.151	.0412	88.82
12 New York Central	6,889	1,169,916,004	12,158,062	48,191,852	60,349,914	8.610	.0515	77.41
13 Erie	2,055	442,653,767	7,093,451	12,403,007	19,496,458	9.735	.0444	83.00
14 Gt. Northern	8,254	478,399,304	17,581,996	11,050,760	28,632,756	3.468	.0596	72.35
15 Ill. Central	4,840	469,374,236	7,935,265	21,212,529	29,147,794	6.022	.0621	79.96
16 Lehigh Valley	1,373	227,627,346	5,534,446	7,630,053	13,164,499	9.518	.0578	87.91
17 Lou. & Nashville	5,039	374,031,933	15,437,875	17,999,115	33,436,990	6.635	.0895	80.58
18 Mo. Pacific	7,235	398,702,693	1,904,094	13,963,480	15,867,574	2.193	.0398	85.46
19 N. Y. N. H. & H.	2,000	387,042,987	7,238,341	14,182,484	21,420,825	10.710	.0553	80.50
20 Nor. & West.	2,238	336,328,515	4,152,001	14,637,078	18,789,079	8.391	.0558	76.05
21 Nor. Pacific	6,668	558,137,462	10,374,362	14,709,234	25,083,596	3.758	.0449	78.79
22 Penn. R.R. Co.	10,509	2,050,577,816	18,973,915	86,045,088	105,019,003	9.993	.0511	81.86
23 Phil. & Reading	1,125	224,547,213	4,027,497	9,716,901	13,744,398	12.039	.0616	73.12
24 Frisco	4,751	396,846,710	5,331,117	6,783,206	12,114,323	2.548	.0306	73.04
25 S. A. L.	3,576	206,596,166	4,921,792	5,088,110	10,009,902	2.683	.0484	77.21
26 Southern Ry.	6,971	532,521,275	9,975,262	17,194,735	27,169,997	3.897	.0512	74.71
27 Southern Pacific	7,125	884,979,271	17,156,188	24,190,795	41,356,983	5.804	.0465	68.68
28 Tex. Pacific	1,952	132,597,718	2,552,058	4,681,830	7,233,888	3.705	.0545	76.85
29 Union Pacific	3,708	387,286,046	15,092,086	11,110,401	26,202,487	7.066	.0676	67.33
30 Wabash	2,476	233,957,892	3,276,986	5,790,715	9,067,701	3.660	.0380	78.11
Totals & Averages	150,316	$14,482,230,418	$276,954,144	$498,873,451	$775,827,595	$5.172	.05357	

Tabulated Display of Selected Statistical Items of Thirty of the More Important Railways

In view of the foregoing, together with others of a similar character it would appear that a tabulated display of some of the principal facts as disclosed in annual reports of our railways to the Government might be of interest, and helpful to those who are really in earnest in this matter, and to those who are not in earnest (if any there be) it may serve as a mild rebuke.

From the report of 183 class 1 carriers for 1923, the following selected items were taken for 30, among the leading ones, and are included in the following tabulation:

(a) Name of line.
(b) Average operated mileage.
(c) Investment in road and equipment (book value).
(d) Cash on hand.

(e) Material and supply accounts.

(f) Total cash and material and supply accounts and operating ratios.

From these items, the average amount of material and supplies, and cash per mile of line has been worked out and the percent of these two items to investment in the railway itself, that is, the fixed physical property is also shown.

A study of this to be of interest and value should only be made with a full knowledge of all related facts and conditions, otherwise erroneous conclusions and unfair comparisons might be made.

First we wish to invite attention to the fact that 30 out of 183 of our class 1 railways have a mileage of 150,316 out of a total of about 250,000 miles, and an investment of fourteen and almost one half billion dollars out of a grand total of more than twenty-two billion for all lines.

In the items of cash, material and supplies, we wish to invite attention to the fact that 30 railways have almost $500,000,000 tied up in material and supplies, and to our friend who intimated that $12,000,000 to $13,000,000 was a whole lot of money to be tied up in cash, material and supplies by a railway company we invite attention to the fact that of the 30 railways shown above, 23 of them have more than $13,000,000 so employed but one has more than $60,000,000, while another shows more than $105,000,000.

Wrong conclusions, however, should not be drawn from the fact that a certain road shows more per mile of line than another as this calculation is intended to prevent unfair criticism, rather than to be made the base of it.

Some lines, notably the Pennsylvania, build much of their equipment, locomotive and freight cars and do heavy betterment work on the line, including new bridges, expensive tunnel work, etc., and the material and supplies necessary for this kind of work does not appear in the reports of other companies that buy all their equipment outside and only carry the usual maintenance of way material.

Again, the New Haven and Philadelphia & Reading show what might be considered a high amount of stock on hand, but on analysis this proves to be on account of their doing a wonderful volume of business on a comparatively short railroad. As an illustration, the Rock Island has 3 million more tied up in these items than the New Haven but owing to its being spread over more than 3 times the mileage it only shows about $3,266 per mile.

The relation between the investment in road and equipment (book value) and the amount of money, material and supplies employed in the operation of the properties as going concerns is not only interesting, but is not a bad yard stick to measure efficient operation, taking of course as heretofore cautioned into account all conditions, particularly the distance from market or base of supplies.

It will be observed that the average of the 30 lines is .05357 per cent of the book value of the roads and is also employed in their operations, the lowest being .0292 per cent, while the highest is .0949 per cent. Application of this method of comparison reveals the fact that such lines as the New Haven and Pennsylvania are in relation to the magnitude of the business involved very close to the average of all lines, and much below quite a few well managed trunk lines that run from 6 per cent to as high as 9.49 per cent.

It is impossible for any one to say with any degree of accuracy just how many millions now in frozen accounts might be thawed out and put to work, as a personal survey by some one competent to consider the matter from all angles would be necessary in order to make a reasonably fair estimate of the whole, but the subject requires no special treatment for one at all familiar with these questions to see at a glance that if those in authority determine upon a systematic and thorough house cleaning they may be assured of the following results:

1.—Those who have already put their house in order will stand endorsed.

2.—Those who through acts of omission or commission, are responsible for the investment of large sums of their employing company's funds in material or supplies that were either not needed or that will be a partial or total loss may meet with a mild rebuke, but the readjustment should not be longer delayed.

3.—The release of this idle money will not only strengthen the financial position of such companies as are the greatest beneficiaries, but at the same time aid in preserving the integrity of the company's capital account.

Mountain Type Locomotives for the Canadian National Railways

The Baldwin Locomotive Works have recently built five locomotives of the Mountain (4-8-2) type for the Canadian National Railways. These locomotives are for use on the Grand Trunk Western Lines in the United States, and are therefore designed and equipped throughout to conform to I. C. C. requirements. They are built to traverse curves of 18 degrees, and while not exceptionally heavy locomotives of their type, are notable examples of this class of power.

The locomotives are to be used on the through passenger trains of the Canadian National between Chicago and Port Huron where the trains will be handled with other locomotives of the same type between Port Huron, Montreal and points east.

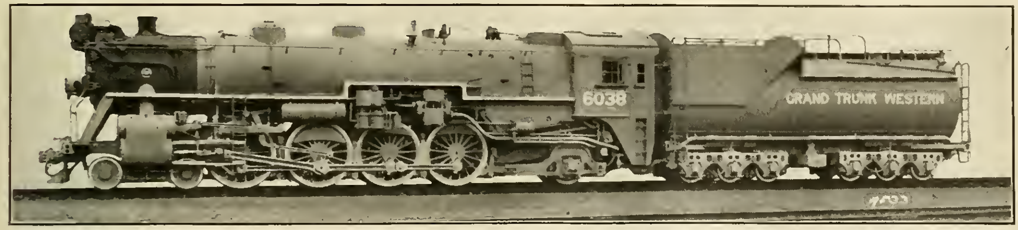
The engines have 26-in. by 30 in. cylinders, 73 in. driving wheels, and a tractive effort of 49,600 lbs. with a factor of adhesion of 4.57. The engines have a total weight in working order of 354,110 lbs. of which 231,370 lbs. is carried on the driving wheels, 61,590 lbs. on the leading truck, and 61,150 lbs. on the trailing truck.

The boiler has a straight top, with a maximum diameter, at the rear end of the barrel, of 90 inches. The firebox has a combustion chamber 36½ inches long, and contains a brick arch which is supported on four tubes. Flexible stay-bolts are applied in the breaking zone, with a complete installation in the combustion chamber; while four transverse rows of flexible stays support the front end of the crown. The large flues are electrically welded at the firebox end. The boiler accessories include a Duplex stoker and Elesco feed-water heater.

The steam distribution is controlled by 14-inch piston valves operated by Walschaerts gear. The valves are set with a lead of ¼-inch, and a power reverse mechanism is applied. The piston heads are of rolled steel, and the main and side rods of open hearth hammered steel, the main rods having solid back ends with floating bushings. The driving axles and main crank pins are hollow bored.

The main frames are of vanadium cast steel with single front sections, and the Commonwealth rear frame cradle is applied. Self-adjusting driving box wedges are used throughout, and the front driving boxes are of the lateral motion type.

The cab is designed in accordance with Canadian National standards. It is built of steel, is wood lined and asbestos insulated, and has a vestibule connection with the tender, so that it can be entirely closed in. It is entered through side doors. Special attention has been given the arrangement of all fittings and piping, and the comfort and convenience of the crew have been carefully looked after.



Mountain or 4-8-2 Type Locomotive of the Canadian National Railways

WEIGHTS, PROPORTIONS AND DIMENSIONS OF NEW MOUNTAIN TYPE LOCOMOTIVES FOR GRAND TRUNK WESTERN

Type	4-8-2
Service	Passenger
Fuel	Bitum. Coal
Builder	Baldwin Locomotive Works
Cylinder, diam. and stroke	26 in. by 30 in.
Valve gear	Walschaert
Valves, piston, diam	14 in.
Clearances:	
Maximum height	15 ft. 3 in.
Maximum width	10 ft. 8 in.
Length, overall	90 ft. 10 in.
Wheel basis:	
Driving	19 ft. 6 in.
Rigid	12 ft. 8 in.
Total engine	41 ft. 9 in.
Total engine and tender	80 ft. 3¾ in.
Weights in working order:	
On drivers	231,370 lbs.
On leading truck	61,590 lbs.
On trailing trunk	61,150 lbs.
Total engine	354,100 lbs.
Tender	250,490 lbs.
Total engine and tender	604,600 lbs.
Wheels—diameter outside tires:	
Leading truck	33 in.
Driving	73 in.
Trailing truck	43 in.
Journals, diam. and length:	
Driving, main	12 in. by 13 in.
Driving, others	10 in. by 13 in.
Leading truck	6½ in. by 12 in.
Trailing truck	9 in. by 14 in.
Boiler:	
Type	Straight top
Diameter	82 7/16 in.
Working pressure	210 lbs.
Firebox length	114⅛ in.
Firebox width	84¼ in.
Staying	Radical
Grate area	66.7
Combustion chamber, length	36½ in.
Tubes, number and diam	188 2¼ in.
Flues, number and diam	40 5½ in.
Length tubes and flues	22 ft.3 in.
Heating surfaces:	
Firebox	206 sq. ft.
Combustion chamber	74 sq. ft.
Tubes and flues	3,731 sq. ft.
Arch tubes	27 sq. ft.
Total	4,038 sq.ft.
Superheating	1,048 sq. ft.
Combined	5,086 sq. ft.
Tender:	
Type	Vanderbilt
Wheels, number and diam	12 33 in.
Journals, diam. and length	5½ in. by 10 in.
Capacity, coal	18 tons
Capacity, water	13,500 U. S. gal.
General data:	
Tractive power	49,600 lbs.
Factor of adhesion	4.57

The tender is of the Vanderbilt type, with cast steel frame and six-wheeled trucks. It has capacity for 18 tons of coal and 11,300 Imperial gallons of water (approximately 13,500 U. S. gallons).

These locomotives were built throughout to rigid specifications furnished by the Railway Company, and they present an exceedingly neat appearance, the workmanship and finish being most excellent throughout. Further particulars are given in the table of dimensions.

The Whaley Constant Pressure Oil Engine

The American Locomotive Company has acquired the exclusive license to use the Whaley constant pressure oil engine on railroads in North and South America. This type of engine differs from present internal combustion engines in that a piston valve driven by the valve motion of the type commonly used in steam engineering practices opens the cylinder clearance into communication with a receiver of large capacity relative to the clearance, the valve opening synchronizing with the period of the fuel injection. Through this feature it is claimed that the combustion pressure does not rise above the compression pressure and that an indicator card similar to that of a steam engine is produced. The limiting of the maximum pressure is expected to make possible the production of an engine which will weigh less than 100 lb. per horsepower.

An engine of this type has recently been constructed at the Sun Shipbuilding & Dry Dock Company at Chester, Pa., and was exhibited to a party of oil engine manufacturers, interested engineers and shipping men running on compressed air. This is a single acting, four-cylinder, two cycle machine designed to develop 750 hp. It weighs only 68,000 lb. or about 90 lb. per hp., a figure which would represent a substantial improvement over current practice. In marine work such a reduction in weight would have obvious advantages and as manufacturing costs are often found to be proportional to the weight of the engine produced, there is also considerable economic advantage to be gained for land engines by the elimination of superfluous metal.

The engineering firm of Parish & Tewksbury, Inc., New York, has had executive charge of this development since February of 1924.

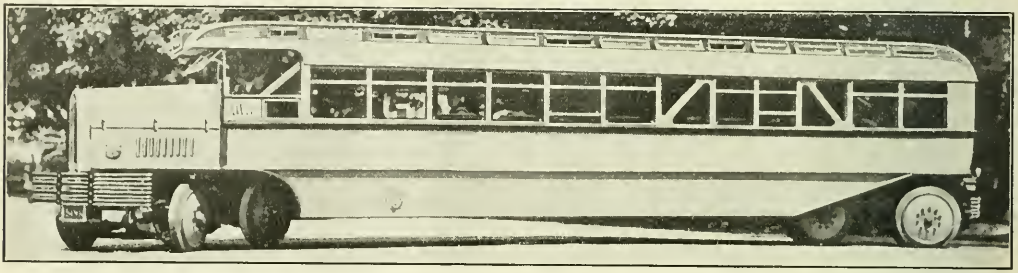
The New Versare-Westinghouse Development in Eight Wheel Gas Electric Coach

Can Turn Around in Aisle the Diameter of Which is Only 5 Ft. Greater Than Its Total Length of 38 Ft.

The eight-wheel gas electric coach built by the Versare Corporation of Albany, N. Y., and equipped electrically by the Westinghouse Electric and Manufacturing Company, has been officially demonstrated and tested before a group, including traction and municipal officials, engineers, and some representatives of the railway, automotive and daily press.

How the Steering Is Accomplished

The swivel-type trucks, which are in reality small chassis in themselves, turn about a king pin placed slightly in the rear of the front axle of each bogie. The driver controls the front wheels of the forward bogie by means of a steering wheel in much the same manner as an ordinary self-propelled vehicle. The steering column is connected through gears and levers to a quadrant to which the tie rods to the front wheels are fastened. The use of this quadrant causes the travel of the tie rods to be such as to keep the bogie wheels tangent to their own circle of turning. The two front bogie wheels are, therefore, only parallel when the coach is running on a straight road. The two front wheels of the bogie are turned in the desired direction by the driver and their pull causes the bogie to turn in the proper direction. The action of the bogie, therefore, is very similar to the action of the ordinary four-wheel vehicle.



Left Side of Versare Coach Showing Position of Wheels in Turning

The fact that this coach, which is 38 feet in overall length, can turn around in an aisle the diameter of which is only 5 feet greater than the length of the coach, is not the least of the amazing features. This is accomplished by means of a patented steering system that permits each wheel to run on a true circle, and the wheels of the rear truck follow almost identically in line with those of the forward truck. The new coach was constructed after exhaustive tests on an experimental chassis had conclusively proven the practicability of the streering mechanism.

The increased number of wheels, as compared with the ordinary coach, makes possible very much heavier loads in either passenger or freight service with even reduced loads per inch of tire cross section. For truck applications, which are also being developed, a capacity of 15 tons can be carried without exceeding the legal load allowed on 8 in. solid tires. With eight springs absorbing the road shocks not only is the pounding effect on the road reduced but also the shocks to the body and chassis. This reduced pounding means longer life for all parts.

The eight wheel vehicle has not made its appearance sooner because there was not a type of steering mechanism that would permit the operation of such a vehicle on narrow city streets and crooked roads. This was one of the first difficulties overcome by the Versare Corporation. The new coach is mounted on 30-inch wheels that are provided with rubber cushion tires. The framing is mounted on two bogies, one in front and one in the rear, that have a wheel base of 54 inches. The distance from center to center of bogies is 29 feet. The tread is 69 inches and the body width 8 feet. The coach is capable of seating 44 persons with room for 52 standing. The total unloaded weight of these vehicles, with seats provided for 44 passengers, approximates 18,000 pounds.

The turning action of the rear bogie is very similar to this. Its two front wheels are controlled by an automatic steering device that permits articulated steering. Tie rods to the front wheels of the rear bogie are attached to a quadrant mounted slightly in the rear of and at the center of the axle. Control for this quadrant is provided by a telescoping rod attached to a point on the frame about 3 feet in front of the axle. In operation, the rod is turned by the body and actuates the quadrant to which are attached the tie rods. This automatic control functions in such a manner as to cause the delay which in practice causes the wheels of the rear bogie to track almost identical with the wheels of the front one.

The steering mechanism is very novel in design and efficient in operation, and eliminates the necessity of a rear steering wheel and operator, or the skidding of the rear wheels that would otherwise occur. It makes possible safe and efficient control of large vehicles.

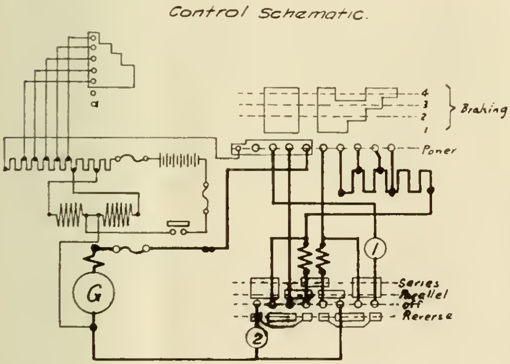
Large vehicles require very high horsepower engine units that make necessary mechanical transmission of great strength and resulting great weight. Such transmissions impose unusual hardships on an operator in ordinary service and are almost physically impossible to operate if the vehicle is used in frequent stop service.

Electric drive or transmission has proven to be advantageous over mechanical drive for such service. On eight-wheel vehicles it has the added advantage of providing traction on four or more wheels, eliminating at the same time the use of many differentials and universal joints. This is a very important point when considering the fact that heavy vehicles in frequent stop service requiring such shifting of gears are apt to be laid up frequently unless the transmission systems are very rugged and well maintained. Eliminating the clutch and gear shifting, lengthens the life of the engine and mechanical parts of the vehicle. Smooth acceleration is also a very important advantage obtained with electric transmission.

The swivel-type trucks, the weight and size of the vehicle and its simplicity, therefore, made it very desirable to provide electric transmission on this coach. An engine-driven generator, two motors, one on each bogie, and suitable control apparatus are, therefore, used instead of mechanical transmission.

The Electrical Equipment

The coach is equipped with a 110-hp., six cylinder engine recently developed by the Waukesha Engine Company. This engine is a model 6-A with 4½ in bore and 5¾ inch stroke, constructed with the Ricardo head. The engine is connected to a Westinghouse generator by means of a flexible coupling and the two are mounted as a unit in the body, on channels lengthwise of the car over the front bogie. The driver's seat is located at the left of the generator which is connected to the rear of the engine.



Control Schematic for Versare-Westinghouse Gasoline-Electric Coach

The generator has a continuous rating of 40-kw. at 1200 r.p.m., and is a specially designed machine provided with a field winding arranged for supplying a small amount of separate excitation to assure a positive pick up and stable operation under all load conditions.

No series field winding is provided on the generator. A resistance is inserted in the generator field to permit varying of the field strength. This arrangement makes it possible to get a high engine speed in a minimum of time under abnormal load conditions, or whenever desirable. It also prevents overloading the engine when its pulling capacity has been impaired. During normal operation the field resistance is at a minimum.

This scheme provides a very flexible overall reduction between the engine and the wheels of the coach, making the speed of the engine practically independent of that of the coach, and, therefore, permitting the engine to be run at high speed with low coach speed. This is a very desirable feature as it gives maximum power at the most needed period of operation. A marked advantage in this scheme of control is its simplicity, giving as it does flexibility with few pieces of electrical apparatus.

The generator is capable of utilizing the full output of the engine and is able without overheating to supply full power to the two Westinghouse traction motors which are mounted on the bogies. The motors are of the vehicle type and have a nominal rating of 28 hp. at 175 volts. They are so constructed as to protect the commutator against dirt and water. This type of construction was necessary on account of the wheel splash and dirt encountered under a truck.

One motor is suspended between the axles on each bogie and is mounted on trunnions carried in links suspended from the truck frame. They are provided with a splined shaft for connection through a splicer joint to a standard Eaton axle. A universal joint is located between the motor and the axle encased in an oil tight ball and socket casing to permit the motor to adjust itself to the variations caused by an uneven roadway. Weight distribution on the axle of the bogies is taken care of by an equalizer connection between the springs of each bogie in such a manner that the axle loading is uniform for various axle settings. The overall reduction from the motor of the wheel is 10.5 to 1. This ratio and the 30 inch wheels permits the use of a high speed motor, and hence provides good space economy and gives good coach accelerating rates with fairly low values of current.

The master controller and braking controller form the principal parts of the control apparatus. The master controller has three operating positions, series and parallel, forward, and parallel reverse. The parallel operating position forward is the first position from the "off" as it is used more frequently than the series. The master controller is mounted directly under the driver's seat and a lever for positioning the controller is located at the left of the driver. A special notching arrangement is provided on the lever, which protects the control from rough handling by the driver. The master controller is ruggedly constructed and provided with blowout coils for handling the heavy current. Contacts are arranged for parallel operation in reverse, in order that traction may be obtained independently on either truck. Wheel slippage with series operation would practically stall the coach.

Braking by Electric Motors

One of the very interesting features of the Versare coach is the arrangement for electrical braking by means of the traction motors. The braking controller is mounted back of the driver's seat. The positioning of this controller is conveniently accomplished by a foot operated pedal. The connections between the braking controller and the master controller are such that the braking controller can be operated with the master controller in the normal operating position. This is a very desirable feature as it makes it unnecessary for the operator to place the master controller in the "off" position, and can, therefore, obtain electric braking with minimum effort and delay.

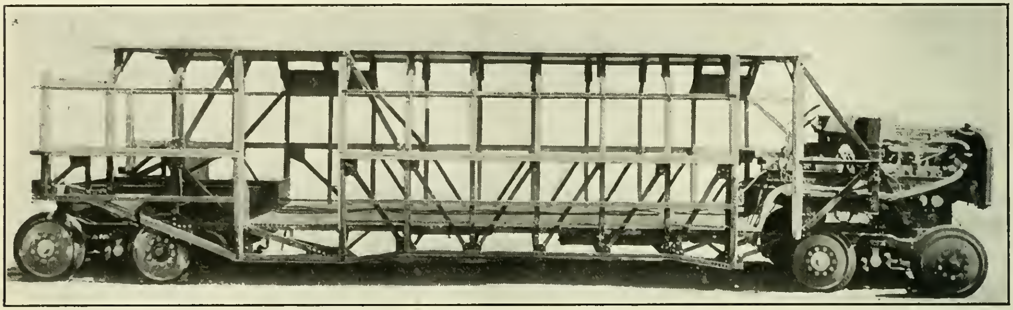
The braking controller has five positions:—"off," and four braking positions. The braking scheme is very simple and is accomplished by cross-connecting the motor field and shunting resistance across the two motors. The braking is intended merely to hold the coach at some constant balancing speed on grade and to adjust the speed to fairly reasonable values on the level. Blowout coils are placed on the braking controller, as very large currents may have to be interrupted in going from one position to another.

Standard automotive Westinghouse air brakes are used with a two-cylinder compressor drive off the engine. The valve handle is placed under the steering wheel. Brake chambers are mounted on 4, 6 or 8 wheels as desired.

In addition to the electrical and air brakes a hand brake is incorporated. This lever is mounted at the left of the driver.

for by standard cross seats and the remainder by a rotunda seat extending along the sides and around the rear end. This leaves a standing space of 1½ sq. ft. each for 52 passengers. Lighting is furnished by 24, 15-watt, 32 volt bulbs in open shade fixtures. Ventilation is obtained by pure air entering through adjustable louvers in the sides and back, air being exhausted through monitor windows.

The air storage tanks, the electrical braking resistance



Structural Details of Versare Body Frame

and a 40 gallon gasoline tank are all mounted under the center of the coach.

How the Coach Operates

The type of control is very simple in operation and can be mastered easily in a few minutes. The engine is first started, of course, as in ordinary practice. The driver then throws the motor control lever into one of the operating positions. He is then ready to go. The engine throttle is practically the only control regularly used, the variations in engine speed being sufficient to produce the desired voltages and, hence, coach operating speeds. The field resistor unit is used only when climbing very steep hills or under abnormal load conditions, as the drooping characteristic of the generator is great enough to prevent overloading the engine during normal operation.

The master controller, connecting the motors to the generator, corresponds to the gear shifting device on the ordinary automobile, but has to be moved less frequently. In normal operation, the parallel position may be used entirely. The controller does not have to be moved to the off position at each step.

A schematic diagram of the control is shown and illustrates very clearly the method of connections used. The battery, which supplies excitation to the special portion of the generator field, is connected by separate contacts on the engine ignition switch.

The pick-up or acceleration with this equipment is very satisfactory on all starts, whether made on the level or on steep hills. The equipment is designed for a maximum speed of 30 miles an hour at 1200 r.p.m. of the engine. The balancing speed on the level is approximately 25 miles an hour with a reasonable engine speed.

Other Interesting Features

The floor of the coach is built up of two sheets of steel separated by V-shaped steel pieces laid across the full length of the body. This gives stiffness and strength. The window and door pillars are wood braced by longitudinal steel members and the roof is monitor type supported by V-shaped carlins giving 6 ft. 4 in. headroom. Seamless tubing diagonal braces are placed at, and opposite, each door, as shown in the illustrations.

The seating capacity is 44. Of these, 32 are provided

Advantages of Gas Electric Drive

It may be well to point out here in brief some of the advantages that are leading to the adoption of gas-electric drive on road vehicles of all designs.

Elimination of the clutch and gear set.

Elimination of costly wearing parts, such as gear box and transmission systems.

Elimination of jar to the body and the improper use of the engine, thus increasing the life of both.

Smoother acceleration—decreasing breakage on freight vehicles and increasing the patronage of passenger coaches.

Flexibility of control, permitting the maximum engine power to be used at very low vehicle speeds.

Practically an indefinite number of speeds.

More economical use of the engine.

Application of power to two, four, six or eight wheels (on six or eight-wheelers) without getting into serious mechanical difficulties.

General Data

Passenger Capacity—44 seated, 52 standing.
Total Approximate Weight—18,000 lb.
Total Wheelbase—29 ft.
Bogie Wheelbase—54 in.
Length Overall—38 ft.
Width Overall—8 ft.
Height Overall—8 ft. 8 in.
Track—69 in.
Interior Height—6 ft. 4 in.
Height of Steps—13½ in. and 14½ in.
Width of Doors—24 in. and 42 in.
Normal Speed—25 m.p.h.
Engine Rating—110 hp. at 2000 r.p.m.
Generator Rating, Continuous—40 kw.
Motor Rating, Nominal—28 hp. each.
Number of Motors—2.
Diameter of Turning Circle—43 ft.
Wheel Diameter—30 in.
Gear Ratio—10.5 to 1.

Snap Shots—By the Wanderer

It has been my lot recently to be domiciled in a hotel from whose windows one looks out over a large passenger station and a yard devoted to freight and passenger storage. The main tracks as they leave the station, sweep through a curve of about ninety degrees in length, but with, I believe, a slight descending grade for outbound trains, but not enough of one to so compensate for the curve that trains can negotiate it without the use of steam and plenty of it.

The result is that every engine as it passes sends a direct message to those in the hotel of its valvular condition, and also a good deal of information as to the way in which it is being handled by the engineer.

I don't know that any investigations have ever been made as to the difference in steam consumption and actual efficiency of a locomotive working with a good square cutoff and exhaust and one with an uneven cutoff and an exhaust of the mama-papa variety. But, I believe that it is generally considered that the square exhaust and cutoff has the advantage so far as economy in the use of steam is concerned per power developed.

I also believe that it is generally conceded that the slipping of driving wheels does not conduce to the longevity of the locomotive or to the prolonging of the period between shoppings.

Both of these remarks were induced by an observation of the performance of the engines leaving the station above referred to.

Now the road is a big one, and well known throughout the country, and yet I can say that, as far as my observation goes, more than half of the engines, that are making the welkin ring with their exhausts, are doing it with puffs or the mama-papa variety. And some of them are so lame that one wonders how it is possible for any valve gear to be so out of square. And when the magnitude of the road is considered, one wonders what the traveling engineers are thinking of that they do not report this state of affairs and use some influence to have it corrected. It may not mean so very much in steam and coal consumption but it makes a very bad impression on the stranger who happens to know anything about locomotive performance, and is a direct reflection on the ability of the man at the head of the mechanical department.

I have not had a chance before, for many years to notice the slipping of driving wheels at any one stated place and so my remarks here may be hypercritical, but it looks as though again the traveling engineers were not doing their whole duty, or else there is a devil-may-care attitude on the part of the engine drivers, when the supervising eye is removed. At any rate the slipping of drivers at this particular point seems to me to be out of all proportion to what should occur with careful handling.

As I said before, the exhaust tells a pretty good story of what is happening on the engine, and these exhausts on the passing and starting of outgoing trains tell a story something like this:

The engineer opens the throttle carefully and admits steam to the cylinder slowly, and the engine moves and starts its train. The driving wheels will make from six to a dozen revolutions and the train will be under way. Then, before the reverse lever is drawn back the throttle is given a sudden opening, and the additional steam admitted, puts such an impulse on the pistons that the wheels start to spin. Then the throttle is closed, the wheels stop in their mad career, and the process is repeated once or twice. Then, as the train has picked up speed, and the reverse lever is drawn back, the throttle is opened again, but without the accompanying slipping that happened when the cut-off was longer.

Occasionally on a long drag of a freight train, where the engine like a willing draft horse is pulling all that it can, the engineer, to hurry matters, opens the throttle too much, and away go the wheels again, and on several occasions, I have seen a perfectly good engine stalled by the repeated openings of the throttle with the resultant slipping, where speed was successively lost until there was no more to lose, and all by trying for the impossible.

Did you ever see a poor and heartless driver lash a willing horse that was pulling all that he could and at as high a speed as he could attain, until the horse lost all heart in his work and simply balked and would not pull at all? Well, it seems to me that these engineers are acting for all the world like that driver. Why when the engine is doing its best can't they let that throttle alone? And if their own common sense does not tell them to do it why don't the traveling engineers drive it into their consciousness? All of which reflects on the head of the department.

I did not think that it could be done, but I find it can be and that in the simplest manner conceivable. All of which goes to show how easily one may be mistaken. In order that you may not be in the dark as to what I am writing about, I will say that I am referring to that long-established nuisance of the smoking or dressing room of the sleeping car—the man or men who sit around there in the morning, smoking or doing nothing, while the other passengers are making their very uncomfortable toilets.

A few years ago the Pullman Company came to a realization of this nuisance and tried to abolish it by the posting of a very small and courteous notice requesting that passengers refrain from using the smoking room as a place of loitering until all the other passengers had completed their toilets. It was wasted effort and expense. It had no effect whatever on that type of mind that pays no attention to any request whatever, unless backed up by a strong and vigorous arm, a backing that the company naturally felt a little delicacy in applying. So the nuisance continued unabated, until now the simple remedy has been discovered and applied, and the remedy consists of nothing more than a slight modification in the fittings of the smoking room.

The modification that has been made is to fit the windows with the same type of corrugated glass that is used in the toilet rooms, and which though translucent is not transparent, and there can be no sight of the passing scenery through them. Then the long lounge is made so that it is not quite as comfortable as the common lounge and there you have it.

Presto. The thing is done. Not that the lounger wishes to really look out and see the passing scenery, for to that he must be quite indifferent, as witness his conduct throughout the day, when he rarely looks out of the window. But I suppose he wants to see something in case he does turn his head away from the entrancing sight of three or four half naked men making their toilets, with different degrees of thoroughness. Then he is not quite as comfortable as he has been accustomed to be, and the trick is done.

The porters report that the scheme works to a charm and that there is no loitering at all in those particular cars.

Of course there has to be a fly in the ointment and that is that these new arrangements, instead of driving the loiterers back into the body of the car in which they have their berths, sends them to the adjoining cars that are not fitted with the new windows and lounges. So that the last condition of those cars is worse than the first because they are cursed not only with their own quota of loungers, possibly I might, without impropriety call them loafers, but with those that are driven by the new windows from their natural habitat.

This makes a glorious state of affairs for the passengers who happen to have been lucky enough to draw berths in the new type of cars, but must cause some added indignation in the minds of those less fortunate who are treated to this extra dose of loafers.

The point in doubt is whether this new arrangement is a permanent cure for the evil, or merely a palliative that will simply serve as a protection to the individual car so long as it alone, in a train, is possessed of it, and that when all cars have been so treated will fail as the notice failed, because the loafer has no other and pleasanter place to go to. But whether this may be the ultimate fate of the scheme or not, it is well worth trying, and be blessed with the prayers of all dressing room sufferers that it may prove to be finally and thoroughly efficacious.

New Union Station in Chicago

The formal opening of the new Chiacgo Union Station marked the completion of a project initiated fifteen years ago when plans were made to replace the old structure by one equal to the demands of the city's traffic. The new station is owned jointly by the Pennsylvania, Chicago, Burlington & Quincy, and the Chicago, Milwaukee & St. Paul Railroads. The Chicago & Alton is a tenant.

The new station was built at the cost of $60,000,000 and covers an operating area of 1,200,000 square feet. At present 300 trains are accommodated daily and there is space for further expansion.

The station building itself covers an area of about 3 acres. It is handling daily over 50,000 passengers and 400 tons of baggage. In connection with it is an office building which will eventually rise to 21 stories only 8 of which are now completed.

A further idea of the station may be gained from the following facts:

In point of number of station tracks it ranks fifth in the United States.

It is the only station of first magnitude in which baggage and passengers are handled entirely on separate platforms.

It is one of the first great passenger stations in which platforms, concourse and waiting room are on the same level.

It has a system of interior driveways and vehicle platforms that practically eliminate the use of street curb space by street vehicles bringing either passengers, mail or baggage.

Among other features of the station may be mentioned the absence of a men's smoking room. A study made of the large stations throughout the country showed that a smoking room served no essential need.

The station has four complete bathrooms and four complete shower baths for the use of patrons. There is also a conference room which will accommodate 125 people and which is available, without charge, to users of the lines.

Notes on Domestic Railroads

Locomotives

The Central of Georgia Railway has placed an order for 10 Santa Fe locomotives with the Baldwin Locomotive Works.

The Florida East Coast Railway has placed an order for 10 Mountain type locomotives with the American Locomotive Company. These locomotives will have 26 in. by 28 in. cylinders and a total weight in working order of 318,000 lbs.

The Savannah & Atlantic Railway has ordered one Mikado type locomotive from the Baldwin Locomotive Works.

The Commonwealth Steel Company has ordered one switching locomotive from the Baldwin Locomotive Works.

The Union Pacific Railroad is preparing specifications covering the purchase of 10 locomotives.

The Harteson Lumber Company has placed an order for one Prairie type locomotive from the Baldwin Locomotive Works.

The Alabama, Tennessee & Northern Railway has placed an order for one consolidation type locomotive with the Lima Locomotive Works.

The Hobi Timber Company has ordered one Mikado type locomotive from the Baldwin Locomotive Works.

The Sierra Railway is inquiring for one locomotive.

The South African Railways & Harbours have ordered 5 Pacific type locomotives and 10 Mountain type locomotives from the Baldwin Locomotive Works.

The Alton & Southern Railway has ordered one Mikado type locomotive from the American Locomotive Company.

The New York, New Haven & Hartford Railroad is inquiring for 3 electric switching locomotives.

The Sierra Railway ordered one Mikado type locomotive from the Baldwin Locomotive Works.

The New York Central Railroad is inquiring for 25 2-8-2 type, 25 2-8-4 type, 25 4-8-2 type and 25 locomotives of the 2,700 class.

Freight Cars

The Baltimore & Ohio Railroad has placed an order for 100 caboose car bodies with the Pressed Steel Car Company and 50 with the Youngstown Steel Car Company.

The Central of Georgia Railway has placed orders for 1,000 ventilated box cars with the Chickasaw plant of the Tennessee Coal, Iron & Railroad Company.

The Illinois Central Railroad is inquiring for 1,000 40-ton single-sheathed box cars.

The Anglo Mexican Petroleum Company has ordered 17 tank cars from the Middletown Car Company.

The New York Central Railroad has placed orders for 500 refrigerator cars, 500 gondola cars and 500 express cars with the Merchants Despatch Transportation Company.

The Sierra Railway is inquiring for 60 50-ton hopper cars.

The Texas & Pacific Railroad has placed orders for 750 gondola cars with the Pressed Steel Car Company.

The Oliver Iron & Mining Company is inquiring for 200 ore cars.

The Missouri, Kansas, Texas Lines Railroad have placed orders for 1,000 50-ton single sheathed box cars with the Mt. Vernon Car & Mfg. Company.

E. I. du Pont de Nemours Company is inquiring for 22 tank cars.

The Seaboard Air Line Railway has ordered 30 caboose cars from the Newport News Shipbuilding & Drydock Company.

M. K. Northan Company has ordered 5 40-ton tank cars from the American Car & Foundry Company.

The Glen Nina Tank Line has ordered 2 triple compartment, 40-ton tank cars, 6,000 gallons capacity, from the Standard Tank Car Company.

The Lower Vein Coal Company has placed orders for 25 mine cars with the American Car & Foundry Company.

The Consolidated Lumber & Supply Company has ordered 250 mine cars from the American Car & Foundry Company.

The Wabash Railroad has placed an order for 12 40-ton box cars with the American Car & Foundry Company.

The Mathieson Alkali Company has placed orders for 20 tank cars with the American Car & Foundry Company.

The Lehigh & New England Railroad contemplates having repairs made to 600 hopper cars.

The Cuba Cane Sugar Corporation has ordered 50 cane cars of 30 tons capacity from the American Car & Foundry Company.

The Canadian National Railway has placed orders for the construction of a number of special cars for the transportation of silk with the National Steel Car Company.

The New York Central Railroad is inquiring for 1,000 70-ton gondola cars.

The Lehigh & New England Railroad has placed a contract covering repairs to 300 hopper cars with the American Car & Foundry Company.

The Ferguson Coal Company has placed orders for 50 mine cars with the American Car & Foundry Company.

The Mid-Continent Petroleum Company has placed orders for 5 tank cars two-compartment 40-ton, 6,000 gallon, and for 3 tank cars three-compartment 400 ton, 8,000 gallon, with the American Car & Foundry Company.

The H. H. Howard Coal Company has ordered 30 wooden mine cars from the American Car & Foundry Company.

The Warner Sugar Corporation has ordered 75 cane cars from the Magor Car Company.

The Havana Central Railroad contemplates buying about 200 box cars of 30-ton capacity.

The Madeira Hill Coal Company has placed orders for 50 mine cars with the American Car & Foundry Company.

The Chicago & Northwestern Railway is inquiring for 25 underframes for cabooses.

E. Atkins & Company, Cuba, has ordered 10 sugar can car bodies of 30 tons capacity from the Pressed Steel Car Company.

Wesselhoeft & Poor, New York city, has ordered 3 flat cars and 3 gondola cars for export from the Magor Car Corporation.

Passenger Cars

The South Australian Railways have placed orders for 25 combination passenger-baggage gasoline motor cars with the J. G. Brill Company, Philadelphia, Pa.

The Seaboard Air Line Railway has placed an order for 4 baggage-mail cars with the American Car & Foundry Company.

The Delaware, Lackawanna & Western Railroad is inquiring for 15 all-steel through line coaches.

The New York, New Haven & Hartford Railroad is inquiring for 35 multiple unit passenger cars.

The Columbus, Delaware & Marion Railway has placed an order for 2 steel parlor cars with the American Car & Foundry Company.

The Lehigh & New England Railroad has placed an order for one gas-electric straight passenger coach with the J. G. Brill Company.

The United Railways of Havana have placed orders for 7 first-class coaches and 12 third-class coaches with the American Car & Foundry Company.

The New York, Ontario & Western Railroad has placed orders for one passenger and baggage gas-electric car and one combination passenger baggage and mail cars.

The Boston & Albany Railroad has placed an order for 3 all-steel dining cars with the Pullman Car Manufacturing Corporation.

The Pennsylvania Railroad is inquiring for 12 passenger coaches for use in the Manhattan tube.

The Chicago & Northwestern Railway is inquiring for repairs to 25 baggage cars.

The Chicago, Lake Shore & South Bend Railway is inquiring for 10 baggage smoking passenger cars and 15 smoking passenger cars.

The Southern Railway has ordered 4 dining cars from the Pullman Car Manufacuring Corporation.

The Chicago, Burlington & Quincy Railroad has ordered 6 combination baggage passenger cars and 4 combination baggage mail passenger cars from the Edwards Railway Motor Car Company.

The Atchison, Topeka & Santa Fe Railway has ordered 3 15 passenger buses from the Studebaker Sales Corporation.

The Chicago, Milwaukee & St. Paul Railway has ordered 3 15 passenger buses from the Studebaker Sales Corporation.

The Union Pacific Railroad is inquiring for two business cars.

Building and Structures

The Missouri Pacific Railroad has awarded contracts covering a roundhouse and machine shop at Bush, Ill.

The Pennsylvania Railroad plans the construction of a new engine house, with facilities for repairing locomotives at East Altoona, Pa.

The Chicago, Milwaukee & St. Paul Railway plan the reconstruction of a grain elevator at Milwaukee, Wis., which was destroyed by fire last year. The cost of reconstruction is estimated at $300,000.

The Delaware, Lackawanna & Western Railroad plans the construction of steel coal trestle at Buffalo, N. Y., to cost approximately $40,000.

The Atlantic Coast Line Railroad has awarded contract for a 14-stall addition to the roundhouse at Florence, S. C.

The Gulf Coast Line plans the construction of a car repair shop, a metal shop, a machine shop and other building at DeQueen, La.

The Boston & Maine Railroad plans the construction of a general office building in Boston, Mass., seven or eight stories high.

The Florida East Coast Railway has awarded a contract for the first unit repair shops at St. Augustine, Fla.

The Norfolk & Western Railway has awarded a contract for an extension to its engine house at Williamson, W. Va., to cost approximately $30,000.

The Chicago, Milwaukee & St. Paul Railway plans the construction of a one-story power plant at St. Paul, Minn., to cost approximately $30,000.

The New York, New Haven & Hartford Railroad has awarded a contract for shop additions at the Van Nest station, New York, N. Y.

The Chicago, Milwaukee & St. Paul Railway will construct a roundhouse at Sioux City, Iowa, to replace a 15 stall roundhouse recently destroyed by fire.

The New York Central Railroad plans the extensions and improvements of its locomotive shops at Avis, Pa.

The Atchison, Topeka & Santa Fe Railway plans additions to its engine house at Winslow, Ariz.

The Mobile & Ohio Railroad is reported to be planning the construction of machine shops, boiler shop, blacksmith shop, flue shop, paint shop and wheel shop at Iselin, Tenn., to cost approximately $1,000,000.

The Boston & Maine Railroad has placed a general contract with the Scully Company, East Cambridge, Mas., covering the construction of a seven-story steel and concrete office building in Cambridge, Mass.

The Southern Railway shops at Knoxville, Tenn., were badly destroyed by fire on August 22. The fire started in the freight car repair shed and destroyed it. together with the coach shop and the paint shop, with a loss estimated at $250,000.

The Pennsylvania Railroad announces that it will receive bids covering the construction of a 14-story office building in Philadelphia, Pa., which is to be the first unit of the new West Philadelphia terminal. The building will have a frontage of 150 ft. on Thirty-second street, with a depth of 250 ft. It will be constructed of steel, with brick walls and stone and terra cotta trimmings. It will furnish working quarters for over 5,000 employees.

The Wabash Railway has awarded a contract for the construction of a one-story, 60 ft. by 120 ft. brick and steel machine shop building at Decatur, Ill.

Items of Personal Interest

H. C. Venter has been appointed superintendent of the Sacramento shops of the Southern Pacific Company, succeeding **D. S. Watkins**, retired, and **W. J. Taylor** has been appointed general foreman of the locomotive department, with headquarters at Sacramento, Calif., succeeding Mr. Venter.

M. E. Pangle has been appointed assistant general superintendent of the Chicago & North Western Railway, with headquarters at Norfolk, Nebr., succeeding **C. H. Reynolds**, deceased.

H. A. Bliss, master mechanic of the Southern division of the Boston & Maine Railroad, has been transferred in a similar capacity to the Fitchburg-Berkshire division, with headquarters at East Dearfield, Mass.

A. R. Cole, master mechanic of the El Paso-Amarillo division of the Chicago, Rock Island & Pacific Railway, with headquarters at Dalhart, Texas, has been transferred to the Oklahoma Southern division, with headquarters at Chickasha, Okla., succeeding **A. R. Ruiter**, who has been transferred to shops at Armourdale, Kan. **A. Hambleton**, general foreman of the locomotive shops at Shawnee, Okla., has been promoted to master mechanic of the El Paso-Armarillo division in place of Mr. Cole.

W. H. Prindall, master mechanic of the Connecticut river division of the Boston & Maine Railroad, has been transferred to the Southern division, with headquarters at Concord, N. H., and **D. J. Ayers**, master mechanic of the White Mountain division, has been extended to include also the Connecticut river division.

J. E. Slater, assistant to the general manager of the New York, New Haven & Hartford Railroad, has accepted the chair of transportation at the University of Illinois, Urbana, Ill.

W. P. Lambert has been appointed special assistant of the Central Railroad of New Jersey, with duties to be assigned by the superintendent of motive power and equipment.

J. P. Roquemore, superintendent of motive power of the International Great Northern Railroad, with headquarters at Palestine, Tex., has been promoted to mechanical assistant, with headquarters at Houston, Tex., a newly created position. **S. T. Armstrong**, master mechanic of the San Antonio division, with headquarters at San Antonio, Tex., has been promoted to position superintendent of motive poyer, with headquarters at Palestone, Tex., succeeding Mr. Roquemore.

V. R. Hasty has been appointed electrical engineer of the Union Pacific Railroad, with headquarters at Omaha, Nebr., to succeed **E. H. Hagensick**, who has resigned to become representative for the **Oliver Electric Company** and the **Pyle National Company**, with headquarters at St. Paul, Minn.

A. W. White has been appointed assistant division engineer of the Big Sandy division of the Chesapeake & Ohio Railway, with headquarters at Shelby, Ky.

Charles W. Extrand has been appointed road foreman of engines of the St. Paul division of the Northern Pacific Railway, with headquarters at Minneapolis, Minn.

A. O. Ridgway has been appointed chief engineer of the Denver Union Terminal Company. Mr. Ridgway is also chief engineer of the Denver & Rio Grande Western Railroad.

John C. McClure, assistant president of the Arizona and Mexican subsidiary roads of the Southern Pacific Company, with headquarters at Tucson, Ariz., has retired.

C. W. Breed, office engineer of the Chicago, Burlington & Quincy Railroad, with headquarters at Chicago, has been promoted to engineer of standards, with headquarters at Chicago, Ill., a newly created position.

E. J. Owens has been appointed chief engineer of the St. John Quebec Railway, with headquarters at St. John, N. B., Canada.

A. G. Smart, general superintendent of the Wyoming district of the Chicago, Burlington & Quincy Railroad, with headquarters at Alliance, Nebr., has retired.

O. M. Stevens, superintendent of the Illinois division of the Chicago, Milwaukee & St. Paul Railway, with headquarters at Savanna, Ill., has been promoted assistant to the receiver, with headquarters at Chicago, Ill., Mr. Stevens will have charge of the installation of motor bus service on the highways supplementary to the railway service.

Supply Trade Notes

John L. Crouse formerly manager of the Development and Supply Division of the Railway Sales Department of the **Westinghouse Electric and Manufacturing Company,** has been appointed as Assistant Manager of the Railway Department, and **A. B. Gibson,** for the past six years manager of the Westinghouse Technical Night School, has been appointed to succeed Mr. Crouse as Manager of the Development and Supply Division.

Mr. Crouse has served with the Westinghouse Company for the past 32 years, first coming to the Company in 1893, when he entered the apprenticeship course. After completing this course, he served in the Test and Inspection Department for four years, and then became connected with the early field development work in connection with the electrifying of the Brooklyn Elevated roads. He also made some of the early tests on the Manhattan Elevated and the Interborough Rapid Transit subways. He has been prominent in the development and revamping of the single phase electric locomotives of the New York, New Haven and Hartford Railroad, and at one time was Superintendent of Electric Shops for this road. He served in the Executive Department of the Westinghouse Company for three years, and has held his previous position as manager of Development and Supply Division, Railway Sales Department, for five years.

Mr. Gibson is a graduate of Clarkson College, Potsdam, N. Y., from which institution he obtained his bachelor of science degree in electrical engineering in 1916. He came to the Westinghouse Company immediately after graduation, and served for one year on the Graduate Student Apprentice course. He was a sales correspondent for two years in the Railway Sales Department before assuming his position as manager of the Westinghouse Technical Night School.

Mr. Gibson has been particularly interested in personnel problems, and has written a number of articles on this subject for such magazines as Industrial Management, Vocational Education, Bulletin of the American Management Association, and numerous college publications.

G. H. Bucher, Assistant General Manager of **Westinghouse Electric International Company,** left New York on July 13 for Seattle, Washington, on his way to Japan, where he will assist in the organization of the newly formed Westinghouse Electric of Japan. Mr. Bucher will said from Seattle for Japan on the Dollar Line steamer President Grant. While in the Orient he will also visit China, the Philippine Islands and other Far East countries to make an investigation into the electrical business outlook in those countries.

The Dearborn Chemical Company is making extensions to its plant at 1029-1037 West 35th Street, Chicago.

The company, established in 1887 and well known for its scientific service in treatment of boiler feed waters, used during its earlier years a leased factory at 23rd and LaSalle Streets, Chicago. In 1904 a favorably located tract of land was purchased on 35th Street in the central manufacturing district, and a new plant constructed, with provision for future growth. However, in 1921 it became necessary to make important additions to the plant, which have served to the present time.

The work now under construction will add 10,000 square feet of floor space. The building is of concrete and brick. New power plant equipment will consist of two 72 x 18 return tubular boilers with a rating of 185 h.p. each, equipped with automatic feed stokers, overhead concrete coal bunkers of 150 tons capacity, to be filled by conveyor which will also handle the ashes. The 150 foot stack will be of brick and concrete and capable of handling 700 h.p., providing for further expansion in the future. A new 16 x 36 Corliss engine will be installed, direct connected to 150 K.W. D.C. 200 volt generator, capable of carrying 25% overload continuous operation.

There will be the necessary pumps and open feed water heater, together with draft gauges, flow meter and CO_2 recorder, and all modern appliances. The cost will be in the neighborhood of $150,000.00. James L. Fyfe, Chicago, is the architect, and Neiler, Rich & Company, engineers.

The company has another factory in Toronto, Canada, and selling branches and warehouses in important cities of the United States and abroad. Products dealt in are Dearborn scientific water treating preparations, Dearborn lubricating oils for all purposes, NO-OX-ID Rust Preventive, and Dearborn Cleaners.

The Locomotive Terminal Improvement Company, with offices in the Railway Exchange, Chicago, and factory at Barrington, Illinois, has taken over the manufacturing department of the National Boiler Washing Company. This includes the manufacture of Leadized Pipe, Leadized Boiler Tubes, both for locomotive and stationary use, post and pillar cranes and other locomotive terminal facilities.

The company will specialize on Leadized Pipe with welded angle flanges and connections and is equipped to supply completely fabricated pipe installations particularly adapted to locomotive terminal requirements. This company will also promote the Direct Steaming System for locomotive terminals and has under development a number of other improvements in locomotive terminal design and construction.

Spencer Otis is president of **The Locomotive Terminal Improvement Company, John S. Maurer,** secretary and treasurer, **F. S. Wichman,** chief engineer, and **W. J. Wignall,** sales engineer.

F. S. Wichman, whose appointment as chief engineer of the Locomotive Terminal Improvement Company, as above noted, has been chief engineer of the National Boiler Washing Co. for a period of eight years. He studied engineering at Armour Institute and was subsequently employed in the engineering department of the American Steel Foundries, the Leonard Engineering Company, H. M. Byllesby Engineering Company, and the Isthmian Canal. Mr. Wichman will retain his position as chief engineer of the National Boiler Washing Company in addition to his connection with the Locomotive Terminal Improvement Company, with office in the Railway Exchange, Chicago.

The Railway Car Manufacturers' Association, an organization of car building companies which has served the industry since 1915, has been succeeded by **The American Railway Car Institute,** an organization of individuals interested in railway car manufacturing and repairing. The new organization succeeds to all the assets and certain other activities of the old association. **W. F. M. Goss,** who was president of the Railway Car Manufacturers' Association, has retired. **J. M. Hansen,** chairman of the board of the Standard Steel Car Company, has been elected president of the new American Railway Car Institute. **W. C. Tabbert,** secretary of the Railway Car Manufacturers' Association, occupies the same position with the new institute. The offices of the new organization are at 61 Broadway, New York City.

The Landis Machine Company, Victor plant, Waynesboro, Pa., manufacturers of Victor collapsible taps, solid adjustable taps and receding chaser taps, announce the appointment of the following agents: **The Chadwick Company,** 549 West Washington Boulevard, Chicago, Ill., for the States of Illinois, Wisconsin, Iowa and Northern Indiana; **A. J. Vaughn,** machinery expedition and sales department, Bourse, Philadelphia, Pa., for eastern Pennsylvania, New Jersey and Delaware; **William H. Harvey,** 225 Dennison Building, Syracuse, N. Y., for Syracuse, Rochester and Central New York.

L. G. Plant has resigned as assistant to the president of the **National Boiler Washing Company** to engage in selling and financing locomotive terminal utilities, with offices in the Railway Exchange, Chicago. He represents the **T. W. Snow Construction Company** as general railway sales agent for this company's unit system locomotive coaling stations, and will also represent the **Locomotive Terminal Improvement Company** as general sales agent for the direct steaming system.

Mr. Plant was formerly an associate editor on the staff of the *Railway Age* and editor of the *Railway Review*. He is a graduate of Stevens Institute and entered the employ of the Southern Pacific as a student of operation. In 1913 he was appointed superintendent of fuel service on the Southern Pacific Lines East of El Paso and was appointed Fuel Engineer on the Seaboard Air Line in 1914. During the Railroad Administration he was progress engineer for the procurement section of the division of finance and purchases.

W. J. Wignall, sales engineer of **The Locomotive Terminal Improvement Company**, was connected with the engineering and purchasing departments of the National Boiler Washing Company for a period of three years. He is a civil engineer graduate of the Armour Institute of Technology and was resident engineer for **G. L. Clausen**, consulting engineer of Chicago.

Benjamin C. Graves has been elected vice-president in charge of car service of the **Union Tank Car Company** and the office of superintendent of car service has been abolished.

Joseph V. Miller, western sales representative of the **Prime Manufacturing Company**, has resigned to become assistant general storekeeper of the Chicago, Milwaukee & St. Paul Railway. C. Arthur Dunn has been promoted to sales manager of the railway division, with headquarters at Milwaukee, Wisc. Mr. Dunn was formerly eastern sales representative, with headquarters at Philadelphia, Pa.

Percy M. Brotherhood, formerly first vice-president of **Manning, Maxwell & Moore, Inc.**, has opened an office at 25 Church Street, New York, N. Y., specializing in machine tools and specialties.

H. G. Mastin has been appointed representative in the sales department of the **Locomotive Stoker Company**, eastern district, with headquarters at New York, N. Y.

The General American Tank Car Corporation has made the following appointments in its tank care sales department: **R. J. Sharpe**, general western sales manager, with headquarters at Tulsa, Okla.; **M. A. Sticelber**, sales representative, with headquarters at Tulsa, Okla.; **Bennett Epstein**, general eastern sales manager, with headquarters at New York, N. Y.; **R. T. Musser**, Pacific coast sales manager, with headquarters at Los Angeles, Calif., and **Z. R. Simon**, southern sales manager, with headquarters at New Orleans, La.

J. C. O'Connor, assistant secretary and advertising manager of the **Galena Signal Oil Company**, Franklin, Pa., has been appointed manager of the railway accounting department, succeeding D. J. Hart, deceased. Mr. O'Connor will retain supervision of the company's advertising.

R. B. Hosken has been appointed general sales manager of the **Sullivan Machinery Company**, with headquarters at Chicago, Ill.

E. J. Tierney, formerly in the mechanical engineer's office of the Missouri Pacific Railroad, has resigned to accept the position as district sales manager of the **Grip Nut Company**, with headquarters at Chicago, Ill. **George P. Hoffman**, formerly general car foreman of the Baltimore & Ohio Railroad, has resigned to become a district sales manager of the Grip Nut Company, and will be located in the East.

The Weir Frog Company and the **Kilby Frog & Switch Company** have been consolidated through the purchase of the stock of **W. W. Stringfellow**, president of the Kilby Frog & Switch Company by the Weir Frog Company.

Edgar J. Correll, formerly division engineer of the Baltimore & Ohio Railroad, with headquarters at Akron, Ohio, has been appointed vice-president of the **Anchor Company**, with headquarters at Chicago, Ill.

E. B. Harkness, assistant secretary and assistant treasurer of the **Illinois Steel Company**, has been promoted to secretary; **A. W. Carlisle** has been promoted to treasurer, and **H. Morrison** has been appointed auditor and a director of the company.

The Ohio Locomotive Crane Company, Bucyrus, Ohio, has purchased the Bucyrus plant of the **Ohio Steel Foundries**, Lima, Ohio, for the production of gray iron castings.

The Dearborn Chemical Company is constructing a concrete and brick building as an extension to its plant, which will add 10,000 sq. ft. of floor space. The cost of the new plant will be approximately $150,000.

Harold Bates has joined the sales department of the **Bridgeport Brass Company** at Bridgeport, Conn. He will be engaged with matters pertaining particularly to sales organization and research.

The Air Reduction Sales Company has purchased the assets and assumed the liabilities of the **Gas Tank Recharging Company**. The Gas Tank Recharging Company owned and operated acetylene plants at Milwaukee, Wis., Bettendorf, and Keokuk, Iowa.

B. H. Elliott has been appointed district manager of sales of the **Union Drawn Steel Company**, to succeed A. D. Dorman, deceased.

E. E. Goodwillie, district sales agent of the **Bethlehem Steel Company**, with headquarters at Chicago, Ill., has been appointed steel sales representative on the Pacific Coast, with headquarters at San Francisco, Cal., to succeed **Leigh B. Morris**, resigned. **John F. Hennessy**, district sales agent, with headquarters at Cincinnati, Ohio, has succeeded Mr. Goodwillie at Chicago.

Charles E. Pynchon, machinery department manager of **Joseph T. Ryerson & Son, Inc.**, with headquarters at Chicago, Ill., has resigned.

E. E. Silk, district sales manager of the **Morgan Engineering Company**, with headquarters in Chicago, Ill., has resigned.

The American Car & Foundry Company plans to expand its plant at Berwick, Pa., by the erection of a new pattern shop, a passenger car shop and also a two story office building. The entire cost is estimated at $232,000.

The Thomson Rail Corporation has been incorporated in New York City to manufacture a patented rail and tie plate. **McLeod Thomson** of Philadelphia is president of the company.

The American Locomotive Company has obtained rights to construct a new type of engine, the patents for which are held by the **Whaley Engine Patents, Inc., 17** Battery Place, New York.

L. M. Zimmer has been appointed general sales manager of the **Linde Air Products Company**, 30 East 42nd Street, New York City, succeeding **L. M. Moyer**, who has resigned as vice-president in charge of sales.

E. H. Hagensick has been appointed sales engineer for the northwestern territory for the **Pyle National Company**, Chicago, Ill., and the **Oliver Electric Company**, St. Louis, Mo., with headquarters at St. Paul, Minn. Mr. Hagensick was formerly electrical engineer for the Union Pacific Railroad.

Obituary

Walter Mason Camp, editor in chief of the *Railway Review*, Chicago, died suddenly in an hospital at Kankakee, Ill., on August 3 of Brights disease. Mr. Camp was born on April 31st, 1867 at Campstown, Pa. He entered railway service with the Lehigh Valley in 1883 as a track walker, and was later a chainman and rodman in the office of the division engineer. In 1887 he left railway work to resume his education at Pennsylvania State College, from which he graduated in 1891. He was then employed as a surveyor on the Southern Pacific. Mr. Camp was placed in charge of construction of the Rainier Avenue Electric Railway in Seattle, Wash., in 1892, and was later promoted to superintendent in charge of operation and maintenance. In 1894 and 1895 he was employed as a work train foreman, surveyor and section foreman on the Seattle, Lake Shore & Eastern, but he left that company in 1895 to take a post graduate course in electrical and steam engineering at the University of Wisconsin. For a short time in 1896, Mr. Camp was an instructor in electricity in the National School of Electricity, Chicago. Later in the same year he was appointed inspector of track construction of the Englewood and Chicago Electric Railway, later being promoted to superintendent of track construction. During this time he had charge of the construction of a counter weight system at Morgan Park, Chicago. Mr. Camp was first employed on the *Railway and Engineering Review*, the predecessor of the *Railway Review*, in 1897, as engineering editor. He was later promoted to managing editor and then to editor in chief. Mr. Camp was known as an authority on railway track. His book "Notes on Track" has been a standard textbook on the subject for many years. He was also author of "Railroad Transportation at the International Exposition, St. Louis 1904," as well as numerous papers published by railway, engineering and historical associations.

New Publications

Books, Bulletins, Catalogues, etc.

Westinghouse Company New 1925-27 Catalogue. The Westinghouse Electric and Manufacturing Company is distributing its new 1925-27 Catalogue of Electrical Supplies. The catalogue presents a complete representation of the apparatus manufactured by the Westinghouse Company, or obtainable through its district offices or agent jobbers, and gives detailed information on electrical supplies.

The publication, which contains 1,200 pages and is profusely illustrated with 4,500 engravings, lists all new apparatus designed and manufactured in the past two years, as well as all the previous established types. Included in the new apparatus for the various industries are the following.

Central stations—Asymmetric Refractors, Station Type Autovalve lightning arresters, OB watthour meter, fittings for pipe structures, Klydonograph, LY switchboard instruments, truck type switchboards, Kilovolt-ampere Hour Meter, Multilux streethoods, Hollowspun lighting standards, combination disconnecting switches, fuses and choke coils, carrier current equipment, Inertaire transformer, Osiso, transformer thermal indicator, Sharples oil purifier, type N metering equipment.

Factories and Mines—SG Vertical Motor, low voltage static condensers, fittings for pipe structures, 200-Amp. Single-operator portable welder, furnace heating elements, electric tachometers, PX-4 portable instruments, 1½ Kw. turbine generator set, clutch type synchronous motors, CF trolley frog for mines.

Architects and builders—Truck type switchboards, ornamental wall brackets, safety switches, fittings for pipe structures, steel switchboards, Sol-Lux luminaires, Junior Cabinet Electric Range, University and Jefferson Newels, Paragon and Octagonal pendants, Solar Glow heaters.

Electric railways—200Amp. Single-operator portable welder, Hollowspun trolley poles, Sharples oil purifier carrier-current equipment, type CL splicer, type BT metallic crossing, Duro molded insulators, railroad type reflectors, double gap section insulators, type CF trolley frog, type SL splicer, Winslow trolley base, electric speed indicator, PX-4 portable instruments, PY-4 portable instruments, automatic melting pots, detachable box brush holders.

A brief description of the company's industrial motors and controllers, power and marine equipment, large switchboards and oil circuit breakers, and railway supplies is also included.

Four indexes for the convenience of the user have been included in the catalogue. A very complete subject index in the front of the book is printed on blue paper so that it can be quickly located, and a style number index for checking invoices is located in the back of the book. A classified index under such classifications as central stations, electric railways, industrial plants, mines, etc., gives a complete list of apparatus applicable to each of these groups of industries, and the thumb index enables the user to locate any section of the catalogue with the least inconvenience.

Some interesting facts about the 1925-27 catalogue, showing the immensity of the task of publication, are that it required more than a ton of ink for printing, 10 tons of type to set up the text, 12,000 yards of cloth and 15 tons of binding to make the covers, and 4,500 engravings for the reproduction of photographs and diagrams. To paste the thumb index tabs in the notches, a feature designed to assure convenient reference, required the labor of 29 operators for 45 days, and the paper used to print the complete edition, if spread out flat, would cover an area of 25,000,000 square feet.

Capacitors is the title of a 24-page bulletin just issued by the General Electric Company, describing the value of this device in power factor correction on electric generating and distribution systems and for direct installation at motor terminals on low voltage circuits. Details are given as to operation, location, etc. Illustrations in the form of charts, diagrams, tables and photographs are used. The bulletin bears the designation GEA-77.

Superpower and the Railways. The Westinghouse Electric and Manufacturing Company has just issued as Reprint 224 an address presented before the Central Electric Railway Association by Mr. E. H. Sniffin, manager of the Power Department on the subject of Superpower and the Railways.

This publication contains some interesting information not only for electric railway companies but also for steam railroad officials interested in electrification. Copies may be obtained from any Westinghouse District office or from the Publicity Department at East Pittsburgh.

The Model Maker, a magazine for those interested in making working models or model engineering, is being published by Messrs. Spon & Chamberlain, 120 Liberty St., New York, N.Y. This highly interesting little publication publishes articles dealing with the reproduction in miniature of all kinds of mechanical contrivances. Aeroplanes, automobiles, steam engines, gas engines and steam locomotives have been dealt with in recent issues. The current issue contains illustrated articles on the Model Makers' Lathe, Locomotive Valve Gears, and a Four-Cycle Gas Engine; all highly interesting and of real educational and recreative value. In addition, a question and answer department is a regular feature, and the sale and exchange columns contain many offerings of value to those interested in model engineering. It is published monthly and the annual subscription price of the publication is $1.00.

Cranes and Foundry Equipment. The Whiting Corporation, Harvey, Ill., has issued a little binder containing individual catalogs of information on cranes, cupolas, ladles, tumbling mills, core oven equipment, steel converters and brass foundry equipment. These catalogs are 8½ x 11 in., and thumb index cards are inserted between the various sections.

Westinghouse New Locomotive Data Pages. As an addition to the loose leaf set of Electric Locomotive Data published by the Westinghouse Electric and Manufacturing Company, this company has now issued six additional pages devoted to the Baldwin-Westinghouse locomotives recently furnished to the Chilean State Railways and the Paulista Railways of Brazil. There is one page devoted to each the express passenger, local passenger, road freight and switching locomotives for the Chilean State Railways, and the passenger and freight locomotives for the Paulista Railways. These may be obtained by requesting Leaflet 20190 Sheets 15 to 20 respectively from any Westinghouse District Office or from the Publicity Department at East Pittsburgh.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXVIII | 136 Liberty Street, New York, October, 1925 | No. 10

Service Tests of the Lima 2-8-4 Locomotive

Interesting Results Obtained on the Boston & Albany Railroad With This New Type of Locomotive

An article was published in the June, 1925, issue of RAILWAY AND LOCOMOTIVE ENGINEERING, giving a description of the new type of 2-8-4 locomotive that had been built by the Lima Locomotive Works and put at work on the Boston & Albany Railroad between Selkirk, New York and Springfield, Massachusetts, a distance of about 100 miles.

Lima Locomotive Works 2-8-4 Type Locomotive With Test Train on the Boston & Albany Railroad

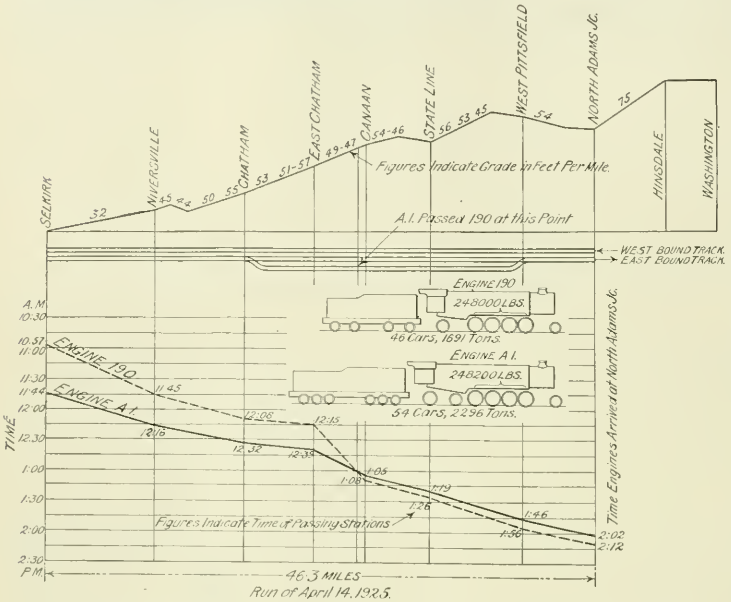
Through the courtesy of Mr. F. A. Butler superintendent of motive power and rolling stock we are enabled to present a preliminary report of the performance of this locomotive in freight service over this part of the line.

Selkirk is situated on the West Shore Ry. about ten miles south of Albany and near the western end of the new Castleton bridge over the Hudson River.

As will be seen from the accompanying condensed profile of the road, it is laid on ascending grade easterly from Selkirk to Washington, which is about 60 miles distant and at the top of the hill down which the road runs into Springfield, Massachusetts. It is over this 60 miles of track in which there are but three slight dips that the test runs were made with trains in freight service.

The figures indicating the grades on the profile are the feet of rise per mile. From which it will be seen that the maximum grade in approaching the summit is nearly one and a half per cent.

The locomotive was received last February and two days later was placed in regular freight service on the Albany division of the Boston & Albany and after a short period of breaking in, it was fitted with the test apparatus and the first test trip with the dynamometer car was run in March.



Profile of Portion of Albany Division of Boston & Albany Railroad Where Tests Were Made and Comparative Test Run of Locomotive A1 and a Mikado Type Locomotive

The test equipment was complete in every particular. There were indicators on the cylinders; and pressure gauges were applied at the dome, and on both the saturated steam side and the superheated steam side of the superheater header, as well as on the steam chest, the exhaust passage, the steam space of the feed water heater, the feed water line at the boiler check, and on the steam and exhaust lines to and from the booster.

Gauge glasses were applied on the corners of the tender tank to indicate the amount of water consumed, the tank having been previously calibrated by weighing the water with which it was filled. Platform scales were also furnished for weighing the coal.

Thermometers were applied to both steam pipes close to the steam chest and to the exhaust passage on the left side. They were also used in the tender tank, in the water line from the feed water heater, in the exhaust steam line to the feedwater heater and in the condensate line from the same.

Pyrometers were applied to the superheated side of the superheater header and draft gauges at both the front and back of the diaphragm.

Nine reliable tests were made between March 28 and April 18. During this period the weather conditions were variable and at times, the conditions of the rail was poor, as light snows were encountered. The average atmospheric temperature for one complete test was 43° Fahrenheit.

The tests were run under normal operating conditions and the results therefore reflect the performance of the locomotive in regular service.

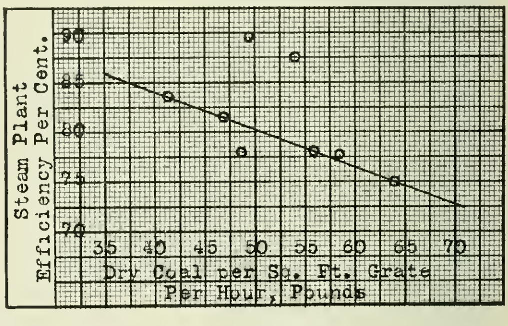
All figures are given as average over the test division and hence are valuable as data which can be used to make comparisons and predictions in regular train operation.

For this reason no attempt was made to correct for grades and curves where these factors might enter into the final results. The various features of the operation of the engine are developed in the several accompanying diagrams.

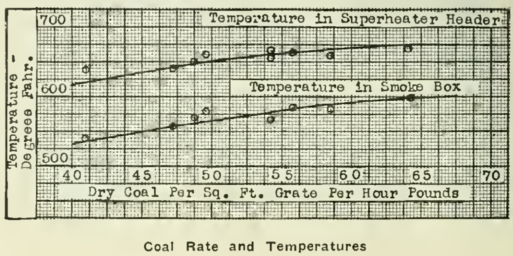
The efficiency of the boiler varied from 72.75 per cent to 89.51 per cent with a difference of but 5 pounds of dry coal fired per square foot of grate per hour. These, however, were extremes, for the majority of the runs showed the general efficiency to be fairly represented by a straight line, running from an efficiency of about 86 per cent with a rate of firing of 35 pounds per square foot of grate per hour, and dropping to 73 per cent when the rate of firing was increased to 70 pounds per hour.

The average efficiency of all runs was 80.5 per cent and this high average was due primarily to the large grate area to which especial attention was called in the previous article describing the locomotive. This large grate area gave an average coal rate of 52.66 pounds per square foot per hour for all of the runs.

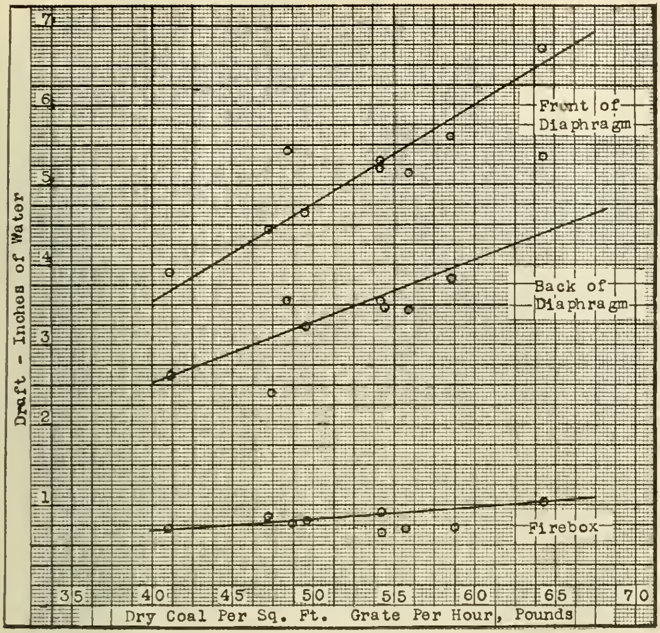
Then there was the large volume of the firebox and the type E superheater which provided for a maximum



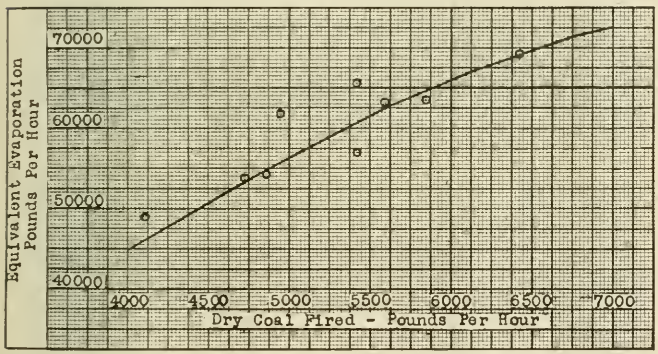
Boiler Efficiency



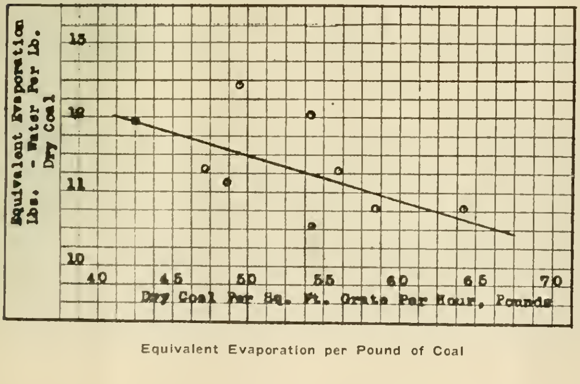
Coal Rate and Temperatures



Draft and Coal Consumption



Evaporation Per Pound of Coal



Equivalent Evaporation per Pound of Coal

gas area through the tubes and flues. To this must be added the feedwater heater. The combination of all of these features gave average evaporation of 8.13 pounds of water per pound of coal as fired, or an equivalent average evaporation of dry coal of 11.37 pounds.

The diagram showing the temperatures developed in the superheater header and low point at which they were held in the smokebox shows the ability of the firebox, tubes and superheater units to absorb heat.

At both these points there was a consistent, but slow rise with the increase in the amount of dry coal burned per hour. But even at a rate of about 64 pounds per hour the temperature in the smokebox was only 599° Fahr. Of course the low rate of combustion favored these conditions. At the same time the temperature in the superheater header was about 670° Fahr. In both cases the actual temperatures lay very close to the medium line that has been drawn on the diagram.

The two diagrams of equivalent evaporation, one giving the total for the total coal fired and the other the rate per pound illustrate very clearly the loss in rate of evaporation as the consumption is increased. The tests, as plotted show that with a coal consumption of 6,425 pounds of dry coal per hour there was a total evaporation of 69,000 pounds of water or 10.74 pounds per pound of coal; while with a consumption of 4,100 pounds the rate was about 11.71 pounds of water per pound of coal. Though there are variations of about 1.5 pounds of water per pound of coal for approximately the same rate of combustion, the straight line of the diagram may be taken as a fair illustration of what may be expected in ordinary road operation, and this indicates that the rate of evaporation will fall off about .06 pound for each rise of one pound in the amount of coal burned per square foot of grate per hour.

The draft as expressed in inches of water, at the front and back of the diaphragm and in the firebox, is fairly represented by the straight lines of the diagram, the actual readings varying from the line most widely at the front of the diaphragm, as would be expected. The ratios between the three points being about as 1, 3.75 and 5.5; varying, of course, from point to point.

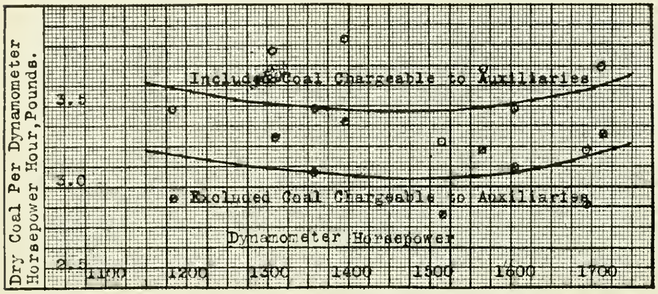
The boiler pressure of 240 pounds per square inch and the limited cut off enabled this engine to produce an average of 1923.7 I.H.P. per hour with an average cut off over the test division of 43.7 per cent.

This resulted in an average water rate per indicated horsepower hour of 20.16 pounds. Coal per indicated horsepower hour was 2.44 pounds average. (Maximum 2.67—Minimum 2.34.) The maximum cylinder horsepower recorded was 3,675.

Some of the performances on individual tests were remarkable. For example the development of more than 1,700 horsepower on about 18.3 pounds of steam, per horsepower and of 2,360 on

18.5 pounds or 2.375 pounds and 2.4 pounds of coal respectively.

In the final analysis, however, it is the horsepower developed at the drawbar that is the reason for an engine's existence.



Dynamometer Horsepower Coal

In this case the dry coal burned per dynamometer horsepower averaged 3.13 pounds. The dry coal per dynamometer horsepower hour averaged 3.13 pounds. (Maximum 3.41—Minimum 2.83.) The maximum drawbar pull was 76,800 pounds of which the booster produced 11,800 pounds. The maximum sustained drawbar horsepower recorded was 3,240.

The range of steam consumed by the engine itself ranged from about 25.2 pounds with a development of about 1,700 horsepower to 27.2 pounds at 1,310 horsepower. Expressed in pounds of coal this was 2.87 pounds and 3.3 pounds respectively.

Unfortunately as everyone knows, the thermal efficiency of the steam engine is low, and necessarily so. The diagram showing the thermal efficiency of this locomotive as laid down by the average line indicates that a little less than 5.25 per cent may be expected in regular service, though on one test, where the engine was developing nearly 1,700 dynamometer horsepower, an efficiency of nearly 6 per cent was attained. This coupled with the low steam consumption per indicated horsepower, which, in these road tests, is crowding very closely upon testing plant figures, leads to the belief that, if the engine is put on a testing plant, some really phenomenal figures will be obtained.

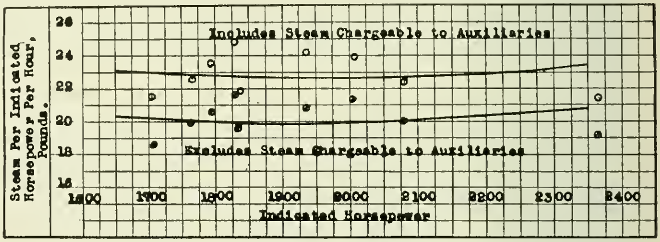
Two tables are appended in which the figures obtained in the tests are given and on which the accompanying diagrams are based. The advantage that will be obtained by the use of this locomotive is an increase in the size of the train unit. Under normal conditions the volume of freight and passenger traffic closely approaches the capacity of the track on this division of the Boston & Albany. Therefore any increase which can be effected in the size of the train unit and the speed of operation relieves this condition.

To effect this requires an increase in gross ton mile hours per locomotive which in turn means a corresponding increase in dynamometer horsepower per locomotive.

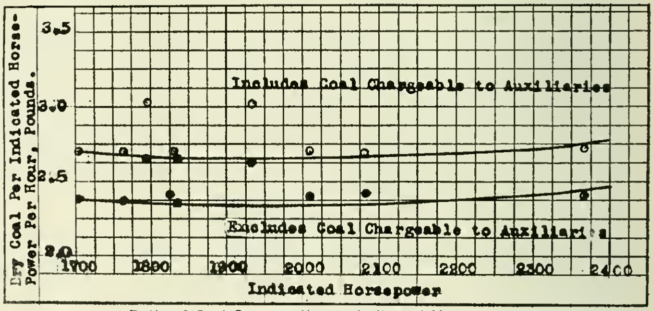
A good comparison between the work of the 2-8-4 type engine and the Mikado type now used on the Albany division was the test run of April 14, 1925. This comparison is shown in diagram form in the illustration of the two engines and the profile of the road.

On this day Mikado engine No. 190 started from Selkirk with a manifest train of 46 cars, 1,691 tons, 47 minutes ahead of the 2-8-4 type class A-1 which had 54 cars, 2,296 tons. Both trains ran without delays, the A-1 overtaking the No. 190 at the point shown on the diagram. At Chatham No. 190 took the outside track so that at the time of passing the two trains were running side by side on parallel tracks under exactly the same conditions. Between East Chatham and Canaan is a difficult part of the line, with many curves and a heavy grade.

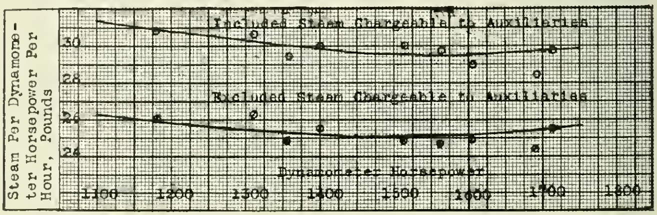
This run may be taken as a fair comparison of the relative ability of the two engines to move freight over the line. The uniform speed of the 2-8-4 type locomotive over the test division is noteworthy as indicated by the uniform slope of the time curve.



Steam Consumption Per Indicated Horsepower



Ratio of Coal Consumption to Indicated Horsepower



Dynamometer Horsepower Steam

As set forth in the previous article descriptive of this locomotive many new features of construction have been incorporated into the design of the Class A-1 Locomotives. As these are vital elements in the economic performance of the engine, their operation was noted with special care to determine their adaptability and usefulness under service condition. The principal new features are: compensated limited cut off in cylinders; cast steel cylinders; the rod drive by which the load of the rear pair of drivers is taken off from the main crank pin; articulated trailing truck and a very large grate area.

In order to establish the best point of limited cut-off trials were run in order to determine one that should be consistent with prompt starting under the worst conditions of rail, grade and position of cranks. It was found that 60 per cent maximum cut off best met this condition. With this cut off an indicated tractive power of 69,400 pounds was obtained at slow speeds. The indicator cards gave a very even turning moment with the result that with this tractive power, given a factor of adhesion of 3.58 there was not any more tendency to slip, than there would be with a full stroke cut off engine, having the same driving wheel load and with 63,500 pounds tractive power. Prompt starting was secured under all conditions.

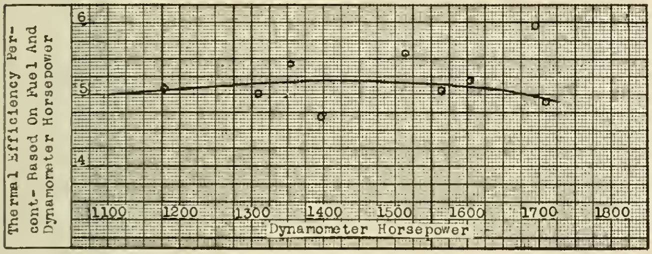
The only comment that can be made after the limited time that the cast steel cylinders have been in operation is that they show no signs of weakness and that all the joints of the exhaust passages remained tight. In fact these joints were never touched.

No trouble was developed with the new style of rod drive the same bearings with which the rods were first equipped remaining in place throughout the test. No hot pins or main box troubles developed although with 240 pounds pressure the piston thrust is 148,000 pounds. Measurements of the wear on the main and rear boxes were made to determine whether the piston thrust was being distributed by the rod drive over two pair of boxes. These measurements showed almost exactly the same horizontal wear in the back as in the main brass thus indicating the correctness of the theory that this rod drive distributes the thrust over two pairs of wheels. Final confirmation of this, however, can only be obtained after more extended service.

No trouble of any kind was experienced with the tracking or operation of this truck and it seemed to adapt itself very well to the track conditions. The engine rode steadily up to the highest operating speeds which the service required. Particular comment is made upon the large ash pan and the ease with which it can be dumped. The accessibility of the booster and stoker is also worthy of note from a repair and maintenance standpoint.

In a later issue further particulars in regard to the performance of this engine will be published.

The following data compiled from the test result of the two locomotives is a comparison on the basis of gross ton miles and fuel:



Thermal Efficiency

Pounds of Dry Coal Fired Per Hour	True Dynamometer Horse Power Which Measured *Gross Ton Mile Hours* A-1	Mikado	% Increase A-1 Over Mikado
4,000	1,200	‡	....
4,500	1,350	‡	....
5,000	1,480	1,200	23.5
5,500	1,600	1,250	28
6,000	1,750	1,320	33
6,500	*	1,420	....
7,000	*	1,550	....
7,200	*	1,650	....

Note.—*A-1 never reached these rates of firing. ‡Mikado never ran at as low rates as these on test. These figures are average over test division.

ENGINE PERFORMANCE

Test Number	Average Working Speed	Average Cut off Per Cent Stroke	Average Indicated Horsepower	Dry Coal Per I.H.P. Per Hour Inc. Auxil.	Dry Coal Per I.H.P. Per Hour Excl. Auxil.	Steam Per I.H.P. Per Hour Inc Auxil.	Steam Per I.H.P. Per Hour Excl. Auxil.	Average Drawbar Pull	Average Dynamometer Horsepower	Dry Coal Per D.H.P. Per Hour Inc. Auxil.	*Dry Coal Per D.H.P. Per Hour Excl. Auxil.	Steam Per D.H.P. Per Hour Inc. Auxil.	Steam Per D.H.P. Per Hour Excluding Auxiliaries	Machine Efficiency of Locomotive	Thermal Efficiency of Locomotive
1	13.25	46.0	1,795.5	3.02	2.67	23.46	20.58	35,350	1,399.7	3.88	3.41	30.10	26.41	82.4	4.67
2	15.76	41.5	1,835.4	2.66	2.36	21.87	19.41	31,150	1,310.8	3.71	3.30	30.64	27.18	79.7	4.98
3	14.42	35.2	1,706.0	2.63	2.37	21.42	18.60	29,500	1,179.1	3.49	3.03	30.99	26.90	77.4	5.07
4	15.63	41.0	1,763.5	2.68	2.37	22.64	19.94	32,450	1,354.2	3.50	3.08	29.48	25.97	79.7	5.39
5	18.18	39.5	1,826.9	2.71	2.34	24.91	21.55	31,216	1,515.2	3.27	2.83	30.04	29.98	82.9	5.77
6	17.62	45.0	2,007.1	2.71	2.41	23.98	21.38	36,000	1,693.6	3.20	2.86	28.41	25.33	83.2	5.99
7	16.84	48.5	2,367.8	2.72	2.41	21.47	19.09	38,067	1,711.6	3.75	3.34	29.70	26.40	80.6	4.88
8	18.03	43.0	2,077.3	2.69	2.42	22.38	20.06	33,300	1,603.1	3.49	3.13	29.00	25.99	79.2	5.19
9	14.79	54.0	1,934.9	3.03	2.62	24.12	20.85	39,650	1,565.8	3.74	3.23	29.80	25.76	83.4	5.03
Average	16.16	43.7	1,923.7	2.76	2.44	22.92	20.16	34,076	1,481.4	3.56	3.13	29.72	26.21	80.2	5.22

BOILER PERFOMANCE

Test Number	Duration of Test Hours	Dry Coal Per Hour	Dry Coal Per Sq. Ft. Grate Per Hour	Equivalent Evaporation Per Hour	Equivalent Evaporation Per Lb. Dry Coal Per Hour	Degree of Superheat at Steam Chest	Boiler Efficiency	Temperature Steam in Superheater Header	Smokebox Temperature	Draft in Front of Diaphragm	Draft in Back of Diaphragm	Draft in Firebox	Pressure at Dome	Pressure at Steam Chest
1	3.48	5,427	54.27	57,171	10.534	205	72.75	652	569	5.22	3.46	0.67	227	208
2	3.22	4,871	48.71	54,273	11.140	194	78.49	650	571	5.43	3.58	0.76	224	209
3	3.33	4,112	41.12	49,203	11.966	190	83.63	637	543	3.90	2.61	0.70	227	195
4	3.13	4,730	47.30	53,729	11.360	195	81.66	639	556	4.44	2.38	0.83	226	202
5	2.82	4,957	49.57	61,729	12.452	216	89.51	660	577	4.63	3.24	0.78	224	204
6	2.87	5,420	54.20	65,343	12.034	213	87.84	663	562	5.30	4.05	0.90	231	211
7	2.95	6,423	64.23	69,320	10.790	236	75.25	672	599	6.70	4.83	1.04	231	211
8	2.83	5,597	55.97	63,111	11.277	220	77.86	665	585	5.15	3.42	0.69	224	203
9	3.46	5,856	58.56	63,333	10.816	210	77.60	659	582	5.59	3.82	0.69	216	201
Average	3.12	5,266	52.66	60,690	11.370	209	80.5	655	571	5.15	3.49	0.78	225	205

The Traveling Engineers' Association

Reports Presented at the Thirty-Third Annual Convention.

The Traveling Engineers' Association held its thirty-third annual convention at the Hotel Sherman, Chicago, on September 15-18 inclusive. There was an unusually large attendance and it was estimated that over 1,000 members and guests attended the opening session. The opening address was made by the president of the Association, W. J. Fee, road foreman of engines of the Canadian National Railways at Lindsay, Ontario. C. G. Bowker, general manager of the Grand Trunk Western Railway also addressed the Association. In his remarks, Mr. Bowker called attention to the opportunity which the Traveling Engineers' Association has in improving locomotive service through the papers and discussions at their annual conventions.

President Fee in his address drew attention to the fact that it was to the interest of all railways to send their traveling engineers to the conventions of the association. The education and experience obtained from an exchange of views would promote efficiency in railroad work and keep the traveling engineer informed as to the latest developments in locomotive equipment and operation. The locomotive being the prime factor in railway operation, the history of its development is a romance which has no parallel in the records of human achievement. Too much credit cannot be given the men whose labors brought into practical form such devices as the air brake, superheater, stoker, booster, power reverse gears, feed water heater, the different valve gears and other numerous devices that are now applied to the modern locomotive.

On this and the following pages is presented some of the reports presented at the convention.

Loss, Damage and Discomfort Due to Improper Handling of Locomotive and Air Brakes

Laws as well as rules govern the operation and maintenance as well as the building of power brakes.

Assuming that good judgment and sound principles have been considered in making rules and laws governing the building as well as operation of brakes on trains, the first thing to consider is the maintenance of this equipment so that it will respond when desired according to laws and rules that were made to work with the builder, as well as to the operator's ideas and instructions.

If this is done, the next thing to consider is the good judgment of the engineer in the operation of the locomotive and brakes to avoid violent slack action in applying or releasing the brakes when slowing or stopping a train. Consideration of the loose slack, which invariably exists in freight trains and at times in passenger trains, should be one of the important items to be given serious thought. The control of this condition, considering other defects, can best be secured by keeping the slack stretched to control the speed or stopping of trains. It is a well-known fact that no jerking or surging of a train will occur if the slack is all stretched, even if a defective triple exists in the train, which is known as a "grabber" or "kicker," causing brakes to apply in emergency when a service reduction is made and intended to be made by the engineer in handling the brake valve.

Defective triples have existed and will continue to exist in the future as in the past. They "dynamite without warning," although a more rigid inspection and repairs would eliminate this trouble to a great extent. After a "grabber" shows up, it should either be located by the train crew and cut out, or if it cannot be located or time will not permit, then control the train by drifting stops or slow-downs and report the trouble on arrival at the terminal. (In handling the train for a drifting stop or slow-down, if the character of the road and other conditions will permit, the engine brake may be used alone, but in such a manner that there will and can be no undue heating of driving tires.)

It should be an unbreakable rule that the engineer be informed by some responsible person before he leaves the terminal, stating the number of empties and loads in his train and as near as possible their location in the train, also the number of brakes operative and otherwise. If this is done and coupled with good judgment on the part of the engineer, a far better job of handling the trains could and should be done.

For example: If a train of one hundred or more cars has about 15 per cent of the loads on the rear and the engineer is not aware of this condition, the adjustment of slack either in or out in using the brakes would be a mere game of chance in avoiding shocks and damage to the draft gear and lading. The ideal way of building up freight trains for brake control as well as hauling would be to alternate the loads and empties in their position in the train; but due to excessive switching this would not work for time and economy on a busy railroad.

It is the opinion of the committee that with long freight trains many draw-bars and draft riggings are damaged and severe shocks in slack action (damaging the lading) result from closing the throttle abruptly, applying the brakes on the engine at the same time as on the train before the slack has had time to adjust or bunch, and releasing the brakes while the train is in motion with the head end moving faster than the rear—than any other method combined.

It is far from the intention of the committee to suggest or recommend how the different railroads should handle their trains or instruct the men in the operation of freight trains. However, it is our opinion that the best way to reduce the damage to equipment and lading is that the engineer set the brakes while the slack is stretched, then gradually close the throttle until the train comes to a rest with no steam in the cylinders. Further, since we have a constantly varying piston travel, the engineer is never sure when the brakes will take effect after any certain brake pipe reduction; therefore, with the slack stretched, these conditions will not be so likely to do damage when controlling the train with the brakes as it would if the slack were bunched.

In connection with the piston travel, the committee wishes to call your attention to Table No. 1, which shows the difference in cylinder pressure and effective braking power with piston travel of various lengths, as compared with that of eight-inch travel. Table No. 2 shows the equalization pressure in brake cylinders from four to twelve-inch travel with the respective brake pipe reductions.

The committee feels safe in saying that the fundamental enemies of the modern air brake are uneven piston travel and leaks. Uneven piston travel causes a variation in every operation of the air brake system so far as the development of power is concerned.

The variation of time required to obtain the braking power expected to be developed from a given brake pipe reduction makes it possible to obtain several times the braking power on one car as compared with another car, or the percentage of braking power to be developed from the design for a given brake pipe reduction, and causes too much braking power on some cars and too little power on other cars, which will cause shocks and jars that will damage the equipment and lading.

In studying the effects of piston travel it must be remembered that in any application of the brakes the brake cylinder pressure obtained depends on two things: the ratio between the volumes of the cylinder and auxiliary reservoir, and the amount of brake pipe reduction. If the brake pipe pressure is reduced ten pounds, the auxiliary reservoir will be reduced slightly over ten pounds, the auxiliary reservoir going into the brake cylinder will create there a pressure depending on the volume of the cylinder and its connecting passages as compared with that of the auxiliary reservoir. But as the auxiliary reservoir volume does not change, we may say that of the two the brake cylinder volume alone is responsible for the pressure obtained. Now the volume depends upon the amount of piston travel; if the latter is short and the volume is small, the ten pounds auxiliary reservoir pressure will create a higher brake cylinder pressure than if the piston travel were longer and the cylinder volume thereby greater.

For example: With a six-inch piston travel a ten-pound reduction gives thirty-four pounds cylinder pressure; while with an eight-inch piston travel you only get twenty-three pounds, and for a ten-inch piston travel only sixteen pounds cylinder pressure is obtained. There is difference enough, it will be seen, to make men take notice who are handling the equipment and brakes on long trains.

For example, with a ten-pound reduction the braking power developed with a six-inch travel is 45 per cent greater than with eight-inch travel; also a ten-inch piston travel gives 38 per cent less braking power than an eight-inch piston travel.

Table 1 gives the results of tests made to show what is done in a service application with a ten-pound reduction of brake pipe pressure. As a matter of fact, the results actually obtained in service will be from two to three pounds lower than shown in the table on account of leakage, etc. (When the above tests were run there was no leakage and everything was air tight.) The effective braking power is that which would be delivered to the brake shoes for the cylinder pressure given. Assuming that the leverage is designed for 60 per cent braking power at fifty pounds pressure, this percentage being now recommended in freight service for steel cars or wooden cars with steel underframe. In practice eight-inch piston travel is usually taken as standard for freight service.

Brake cylinder pressure and braking power developed with an 8″ x 12″ cylinder, and having 50 cubic inches clearance, and standard cast iron auxiliary reservoir, with a ten-pound brake pipe reduction, and different piston travel, no losses whatever being considered, nominal braking power being 60% on fifty pounds cylinder pressure. Tables similar to the above can be made from any other brake pipe reduction, showing a variation similar in character, but different in amount, the latter being greatest for small brake pipe reductions. As a result it will be readily seen that if in a train some brake cylinders have long piston travel and some short, a very uneven braking power will be developed from any brake pipe reductions. This will cause some cars to be retarded more than others, from which shocks and unnecessary strains on draw-bars will result.

TABLE No. 1

Piston travel	Cylinder pressure	Effective braking power	Comparison with 8″ travel
4-inch	52½ pounds	63%	130% greater
5-inch	41 pounds	49%	78% greater
6-inch	34½ pounds	39%	44% greater
7-inch	27½ pounds	33%	20% greater
8-inch	23 pounds	27½%	
9-inch	19 pounds	23%	16½% less
10-inch	16 pounds	19%	31% less
11-inch	13 pounds	15½%	44% less
12-inch	11 pounds	13%	53% less

The proper piston travel is that which will develop approximately fifty pounds cylinder pressure when the auxiliary and brake cylinder pressures become equalized from an initial brake pipe and auxiliary reservoir pressure of seventy pounds when a twenty-pound brake pipe reduction is made. This fifty-pound cylinder pressure will then be the limit of a full service application, and should be obtained simultaneously on all cars. Table No. 2 shows approximately the pressure at which the cylinder and auxiliary reservoir above mentioned will become equalized for different piston travels, and the brake pipe reductions required to give this equalization.

TABLE No. 2

Piston travel	Equalization pressure	Brake pipe reduction
4-inch	59 pounds	11 pounds
5-inch	57 pounds	13 pounds
6-inch	55 pounds	15 pounds
7-inch	55 pounds	16½ pounds
8-inch	51½ pounds	18½ pounds
9-inch	50 pounds	20 pounds
10-inch	49 pounds	21½ pounds
11-inch	47 pounds	23 pounds
12-inch	46 pounds	24 pounds

Particular attention should be given in this table to the large variation in brake pipe reduction, the short piston travel requiring a smaller reduction and equalizing at a higher pressure than in the case of longer travel. To illustrate the detrimental effects of having such a condition in a train, let us suppose that two freight cars are coupled together, each having a light weight of 35,000 pounds and each being equipped with an eight-inch brake cylinder and cast iron auxiliary reservoir, the first car having a piston travel of eleven inches and the second car a travel of five inches. It is very plain that if the brakes are applied with a twenty-pound brake pipe reduction the pressure in the brake having the eleven-inch travel would not be equalized. Therefore it would be necessary to make the reduction twenty-three pounds instead of twenty. At the same time a thirteen-pound reduction was enough to equalize the pressure in the cylinder with the five-inch travel. Consequently ten pounds of brake pipe air was wasted from the second car, and it obtains a cylinder pressure of fifty-seven pounds, while the first car only obtains a cylinder pressure of forty-seven pounds. Moreover the higher pressure on the second car is obtained in less than six-tenths of the time it takes to get the lower pressure on the first car. That is, there were fifty-seven pounds in the cylinder of the second car mentioned at the time that only twenty pounds were in the cylinder of the first car. Let us suppose that these two cars be arranged to deliver 60% braking power with 50 pounds cylinder pressure, then fifty-seven pounds represents 68½% braking power, and forty-seven pounds represents 56½%; 68½% of 35,000 pounds is 24,000 pounds, and 56½% is 20,000 pounds. As a result, the stopping power of the second car is 4,000 pounds greater than the first car. Assuming that we run at a speed of twenty miles per hour and a co-efficient of friction of 20% (this will be a fair average for this condition), a draw-bar pull of about 800 pounds is maintained between the two cars throughout the stop or until the release of the brakes.

If the release is made before coming to a stop, the brake pipe pressure need only be raised one and one-half pounds to start the first car to release. The first car having a low cylinder pressure would fully release before the second car begins to release, resulting in a draw-bar pull for a short time proportional to the entire braking power of the second car, or in this case of about 4,000 pounds. But still another condition might arise. Suppose a fourteen-pound brake pipe reduction should be made, the second car would equalize at fifty-seven pounds, or 68½% 24,000 pounds braking power, while the first car would only have a cylinder pressure of twenty-four pounds, the latter representing 29% braking power or 10,000 pounds retarding effect. In this case the draw-bar pull between the two cars during the application of the brakes would be about 2,800 pounds, an amount that would be sufficient for the first car to bring the second car loaded with 100,000 pounds of freight from a standard still up to 25 miles per hour in one minute.

It is clear that uniform piston travel is most desirable. If the piston travel is unnecessarily long, the brake cylinder pressure is thereby reduced and the efficiency of the brake is correspondingly impaired. In addition, a greater quantity of compressed air is consumed in brake application than would be otherwise necessary, thereby entailing greater demands upon the compressor and causing excessive fuel consumption. If the piston travel is too short, it is apt to cause a constant dragging of the brakes against the wheels while the brakes are released and cause too high a brake cylinder pressure when applied with an accompanying liability of sliding wheels and rough and sudden stops. Besides, with a constantly varying piston travel the engineer is never sure what retarding effect will follow any certain brake pipe reduction, and he will lose confidence in the brake.

It has been said, and truthfully so, that 85% of damage to lading and equipment is done in the yards. In proof of this, the committee calls your attention to Table No. 3 A. R. A. Circular No. 31. This chart shows the weight of impact between cars at different speeds. It is no unusual thing to see cars come together in yards at speed five, eight and even ten miles per hour. Diagram "A" is a record of the impact between two loaded cars, weighing 132,000 pounds each, without any draft gears, and shows the striking speed in miles per hour, plotted against the force in pounds. Note that striking at just a little more than one-half mile per hour brings the forces of reaction at the point of contact up to the weight of the car, 132,000 pounds. Striking at one mile per hour brings

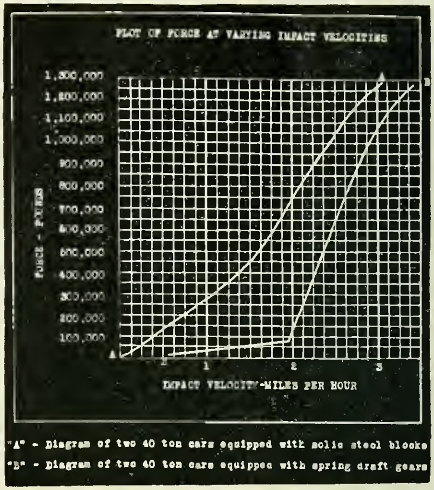


Table No. 3—Chart Showing Weights of Impacts Between Cars at Different Speeds

the forces up to about 270,000 pounds. Striking at one and one-half miles per hour brings the force up to 455,000 pounds; and if the striking is done at the speed of two miles per hour the force will be 730,000 pounds, provided the car is not already overstrained and given away under the force thus developed.

Diagram "B" represents the force when two loaded

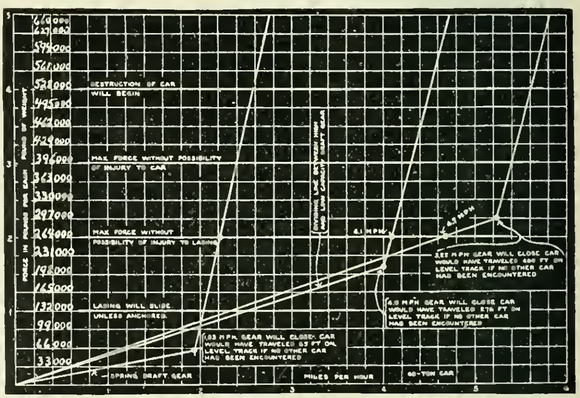


Table No. 4—Chart Showing That Spring Draft Gear Closes at Speed of 1.93 M. P. H. and Car Stops

40-ton cars weighing 132,000 pounds, having tandem spring draft gears, are run together. This type car with tandem draft gear was selected because so many box cars of that capacity are in use.

Diagram "B" shows that the draft gear goes solid at a speed of 1.93 miles per hour. At this point the force of reaction between the cars is only about one-half the weight of the car, or 62,000 pounds, a very small force for the car to stand. After the draft gear goes solid, the force rises very rapidly with the increase in the striking speeds. Even as low a striking speed as two miles per hour, an increase of only seven one hundredths miles per per hour (7/100), the force of reaction has increased to about 375,000 pounds. Another quarter-mile-per-hour increase, bringing the speed up to 2.25 miles per hour, brings the force up to about 635,000 pounds.

Now let us refer to Table No. 4 A. R. A. Circular No. 35. This chart shows that with the spring draft gear the gear closes at the speed of 1.93 miles per hour and the car stops. The car would have traveled sixty-five feet if no other cars were encountered (on level track). With low friction draft gear at a speed of four miles per hour the gear closes and the car stops. The car would have traveled 276 feet if no other cars were encountered. With high capacity friction draft gear it closes at a speed of 5.25 miles per hour and the car stops. On level track the car would have traveled 480 feet if no other cars were encountered.

That is what is taking place almost daily in some yards and out on the line of road. You can imagine what is happening to the equipment and lading in 90 and 100-car trains when the engineer closes the throttle suddenly or shoots the independent brake valve to the quick application position.

In proof of the committee's contention that 85% of rough handling is done in yards, they had placed a machine in a 62-car train. The impact machine was placed in the tenth car from the engine and it shows that 2.1 miles per hour was the greatest impact on the line of road, except once when the engine brakes were used purposely to see just what the impact would be with a speed of twenty miles per hour and the slack gently bunched. Even with this light handling of the independent brake valve, the impact was 4.9 miles per hour, while the machine showed that the car was rough handled in both terminals.

Too much stress cannot be laid on the handling of passenger trains. It is here that the public lets out its loudest cry, and justly so. There can be no more disgraceful performance on a railroad than for the engineer to set every one on their heads in stopping and starting a passenger train.

The report was submitted by a committee, the members of which were James Fahey, traveling engineer, Nashville, Chattanooga & St. Louis; N. Suhrie, road foreman of engines, Pennsylvania; R. Hammond, traveling engineer, New York, New Haven & Hartford; C. Dellinger, New York Central and F. W. Sefton, supervisor of locomotive and fuel performance, Cleveland, Cincinnati, Chicago & St. Louis.

Drafting Locomotives for Efficiency and Economy in Fuels

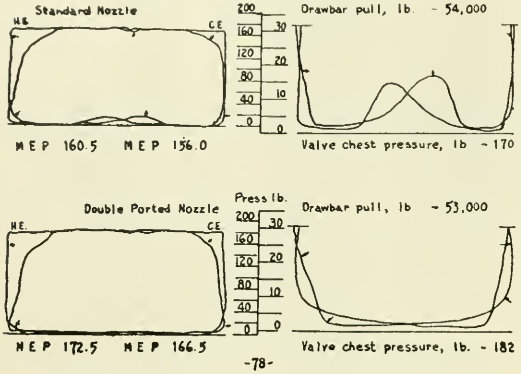
The committee appointed to report on the subject, "What progress has been made in drafting of locomotives, with a view of increased efficiency and economy in coal and oil fuels?" submits the following for consideration, not with the idea that we have done justice to the subject or even partially covered it. We feel that it is perhaps one of the most important questions connected with transportation and fuel economy, and that it has not been as thoroughly tried out by the railroads as the subject deserves. With this in view, we offer this paper, hoping to provoke such discussion as will bring out valuable information on engine drafting that these proceedings will be worthy of consideration by the railroads. Believing that there is no class of men who are better qualified by long experience, to pass on this subject, we are placing it before you.

As the subject covers both coal and oil-burning locomotive, we will first deal with the coal burners.

The term "draft" as applied to combustion means "a current of air," so as your committee understands the subject, the predominating feature connected with it is air. Those of you who years ago were locomotive firemen and engineers can vividly recall that, as a rule, your greatest trouble was lack of steam, and much depended on how the firemen fired the locomotive and how the engineer handled it in order to pull the train and make the schedule. You will remember that the locomotive of those days had the ash-pan fastened tight to the mud-ring and all the air admitted came through two small dampers, one in either end.

Those conditions were changed with the advent of the large locomotive with superheater and brick arch. Additional air openings were placed between the mud-ring and the top of the ash-pan on wide fire-boxes, and with these improved methods of drafting, regardless of the size of the train or the schedule, the question of steam became the least of the engineers' troubles. Even the student fireman of today knows, or soon learns, what sufficient air means to the steaming qualities of the engines; he therefore carries the fire as light as it is consistent with the work the engine has to do, in order that the air can pass freely through the fire-bed and properly support combustion.

The importance of air in relation to the subject has been stated and how to regulate its admission to the fire in order to burn the fuel most economically is the next step. Before discussing the question from a practical standpoint, let us briefly see what the scientific man has to say about air and its relation to combustion. He tells us that a good grade of coal has about 14,000 heat units in each pound, and in burning coal in a locomotive it requires about nineteen pounds of air to burn each pound of coal to carbon-dioxide gas, which must be done in order to extract these heat units from the coal. He also tells us that where sufficient air is not furnished, a gas known as carbon-monoxide is formed, which produces but 4,400 heat units, so we can readily see what the furnishing of a proper amount of air means to the fire to support combustion and to burn coal most economically. He further tells us that one pound of air at atmospheric pressure equals about twelve cubic feet, and it takes approximately 250 cubic feet of air to support the combustion of one pound of coal in a locomotive fire-box. According to these figures, it will take about 3,750 cubic feet of air to support the combustion of one scoopful or fifteen pounds of coal, and as a box car thirty-six feet long, eight feet wide and eight feet high hold but 2,300 cubic feet of air, its volume is not sufficient to rightfully burn one scoopful of coal, giving us an idea of the vast amount of air that must pass through a fire to make the heat units available that are in the coal; and, considering the fact that air costs nothing, we believe the question to be in order to inquire, "Are our engines getting sufficient air through the fire, and how many roads have used vacuum gauges in ash-pans to determine this?"



Typical Indicator Cards—Standard and Double Ported Nozzle
Standard Card Back Pressure Card

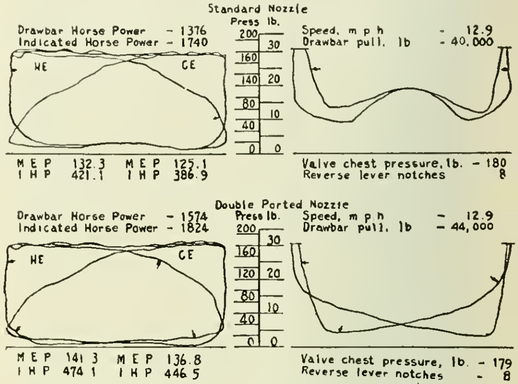
How are we going to regulate air openings into the ash-pan through the grates and fire-bed to admit the proper amount of air? Or, in other words, the problem is how to draft the engine to burn fuel effectively and economically and produce a sufficient amount of steam to handle the trains and make the schedules. To state it differently, it is a mechanical problem of pounds of air per pounds of coal, and pounds of coal per units of heat.

Our experience has been that, as a rule, few changes have been made in recent years in the form of finger or table grates with a view of finding the proper amount of air openings they should contain, and we wonder how many companies have estimated how many square feet of air openings should be made in the ash-pans as compared to the air openings in the grates, the area of the flue openings, and the size that the smoke-box and stack should be in relation to the total grate area. Locomotives being force drafted by exhaust steam from the cylinders, it follows that the larger the nozzle tip that can be used to make the necessary steam, the lower will be the back pressure in the cylinders, consequently the more freely the engine will work and the more easily and effectively it will handle its load.

Now let us see what is being done by some of the roads in drafting their engines. One of the large roads has installed a table grate with 18% of air openings, which they claim is giving them ample air for good combustion and materially reduces fuel losses through the grates when firing up in terminals and in service on the line. In connection with this, they are using on all their large power double ported nozzles, which have separate cavities for the exhaust of each cylinder; the exhaust from one side comes through the dumbbell-shaped opening from one nozzle stand, while the exhaust from the other sides comes out of the two holes on each side of the dumbbell opening. Indicator cards taken show a reduction of back pressure by use of this type of nozzle as compared to the standard one they had formerly used.

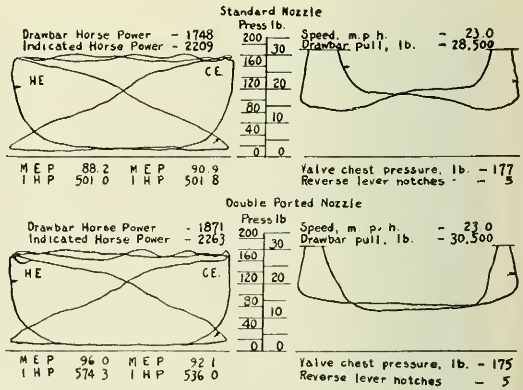
Other companies are adopting grates with as high as 55% air openings and claim by doing so they are able to increase the size of their nozzle tips and get a better draft, save fuel and make much longer runs without cleaning fires. We have not been furnished with figures to show the amount saved, although we have been given examples of remarkably long runs being made by heavy passenger trains on mine-run coal without cleaning the fires.

A nozzle tip that was described by Mr. Woodbridge



Typical Indicator Cards—Standard and Double Ported Nozzle
Standard Card Back Pressure Card

in his paper at the 1920 convention, in which he stated that after returning from this convention they took one of their standard passenger engines, applied a back pressure gauge, also a "U"-shaped water vacuum gauge connected to the smoke-box, with a view of showing the actual results obtained under similar conditions in actual service from nozzles of different sizes at the same speed with the same throttle openings and full boiler pressure.

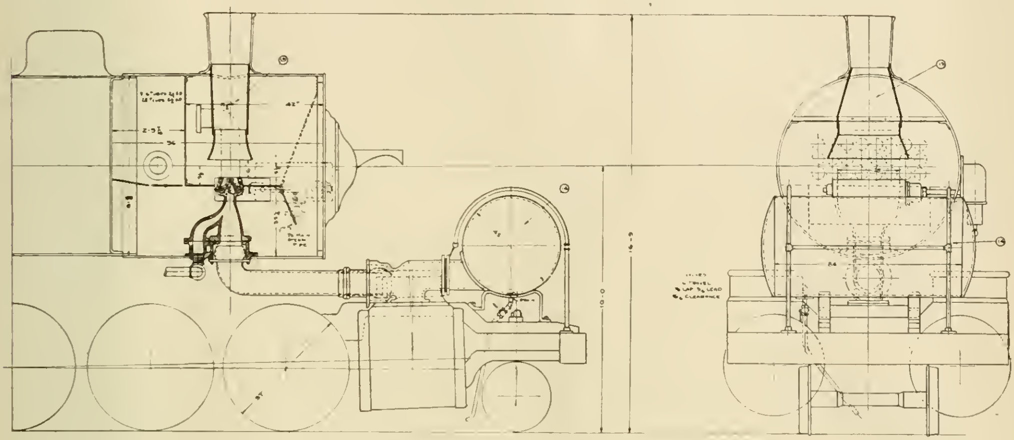


Typical Indicator Cards—Standard and Double Ported Nozzle
Standard Card Back Pressure Card

Tests with a standard nozzle of 5½ in. diameter with a ⅜ths round bridge inserted just below the opening of the nozzle at a speed of sixty-four miles an hour showed a 5½ in. vacuum with twelve pounds back pressure. Then different sizes of nozzles were tried and it was finally found that a nozzle of 6¼ in. diameter developed a 6 in. vacuum with six pounds back pressure, or increased the vacuum from 5½ in. to 6 in. and decreased the back pressure 50%, which greatly increased the efficiency of the locomotive and reduced the fuel consumption. We were not given figures as to just what was the amount of decrease in fuel consumption. In considering these changes you will note that the nozzle opening was increased approximately 21% and, as stated above, this reduced the back pressure 50%. By this means the velocity of the jet of steam was reduced. Consequently it did not travel at as high a rate of speed as when escaping from the 5½ in. round nozzle.

The question naturally follows: What caused this greater vacuum in the front end with the increased size of the nozzle tip? Our theory is that since it is an established fact that a circle is the shortest possible boundary of any area if an engine is equipped with a round nozzle the column of exhaust steam will have less surface area for entrainment than it would if its cross section were 25 in. in diameter, and, under the same conditions, showed a vacuum of 4.5 in., indicating that the velocity of the exhaust had been retarded by coming in contact with the inner surface of the smaller stack and that the entrainment of the gases had been facilitated by the use of the larger stack, thus increasing the vacuum and making the use of a larger nozzle possible with a decreased back pressure in the cylinders.

It has been stated at previous conventions that the petticoat or lift pipe was more economical on fuel than the extension stack. As both serve the same purpose, that is, to line the exhaust steam with the stack and carry the gases out of the smoke-box. We can see nothing in favor of the former over the latter in the way of saving fuel, but there is this in favor of the extension stack



The Lewis Exhaust Governor—Design for Mallet Type Locomotive

of any other form. It therefore naturally follows that a nozzle of any other shape or any device that will split this jet of exhaust steam, will increase its surface or exposed area of the exhaust jet of steam for entrainment and that a greater vacuum will be produced in the smoke-box. This in turn allows for an increase in the openings of the nozzle over that of the round nozzle and brings about a reduced back pressure in the cylinders, which results in greater locomotive efficiency.

The size and length of the stack is often mentioned in connection with the draft of a locomotive. At the present time, however, the length of the stack is governed largely by the height of the overhead bridges, tunnels, etc.; therefore this feature cannot be considered, and it is the opinion of your committee that by increasing the diameter of the smoke-stack good results will be obtained. As a rule, it is understood by locomotive men that in order to get best results in drafting locomotives the exhaust must fill the stack, and if this does not occur there will be a down draft. We do not believe this to be the case, for the reason that we would not get the results we do by means of the blower in creating draft on the fire; therefore your committee thinks that by the use of a larger size stack the retarding or slowing up of the exhaust by coming in contact with the inner sides of the stack is reduced and consequently a better draft will result. Tests made on a large passenger engine with a 20 in. stack at a speed of sixty miles an hour with 200 pounds pressure showed a 4 in. vacuum in the smoke-box. This same engine had the stack changed to one of that there is not the trouble with its coming loose and causing steam failures, and if it is adjusted correctly and of the proper size we believe that its use is an advantage over that of the petticoat or lift pipe.

We are also showing a drawing of the Lewis Exhaust Governor as applied to a Mallet engine. After the application of this device on Mallet engines there was a remarkable reduction of the fuel consumption and the tonnage over the ruling grade of 1.55% was increased 285 tons; however, when the appliance was installed on the engines referred to, they had been practically rebuilt and a number of changes made on the locomotives in addition to the application of this draft device, therefore it cannot be determined just how much this draft device contributed to the increased tonnage and decrease in fuel. The engines were originally equipped with piston valves on the high-pressure cylinders and slide valves on the low-pressure cylinders. Both engines were controlled by Walschaert valve gear coupled together with one power reverse gear.

Before rebuilding these engines, indicator cards taken showed that the low-pressure engine, while performing with fair results up to a speed of fifteen miles an hour, was not doing well at higher speeds. In fact, at thirty miles per hour and with a cut-off of about 30%, the low-pressure engine was not developing sufficient power to pull the locomotive, while the high-pressure engine was doing all the work. At these higher speeds the low-pressure engine was working at the same cut-off as the high-pressure. On the low-pressure engine the exhaust pressure was fifteen to twenty pounds, resulting in high compression. This high compression was hard on the machinery, and rod maintenance was heavy, the cylinders became loose and frames were broken.

When rebuilding the engines, 14 in. piston valves were applied on the low-pressure cylinders with a special air reverse cylinder installed, by which was maintained a constant long cut-off, even though the high-pressure engine was hooked up to a short cut-off. With the addition of the Lewis draft arrangement the combination of these changes relieved the high back pressure on both engines. The low-pressure cylinders now exhaust at from six to eight pounds and perform useful work up to a speed of thirty-five miles per hour. These engines have exceptionally long flues and very shallow fire-boxes. The Lewis draft arrangement provides a large receiver for the exhaust steam of the low-pressure engine, which is fed through the exhaust nozzle at a more constant pressure than by the direct emission of the exhaust steam through the nozzle. This more uniform draft is especially desirable when it is necessary to furnish a large quantity of steam at low speeds when the exhaust would otherwise cause a more jerky action on the fire. Before rebuilding these engines, they were used almost exclusively in coal traffic, but since they were rebuilt and changed, as quoted above, they are taking their turn with Santa Fe type engines in all classes of through freight service.

There have been a number of good papers on the subject of drafting oil-burning locomotives heretofore offered by members of the association that were connected with oil-burning railroads, and there is very little, if anything, that can be added in the way of information on the subject.

While there are many individual ideas as to the most successful methods of draft arrangements in use in locomotives burning oil, all agree that in order to successfully and economically burn it, it is necessary that a sufficient amount of air be admitted and air leaks in the fire-pan must not exist.

Now the question is: What amount of air should be admitted and in what way in order to burn the oil and get the best results, or how to draft the engine in such a way that will extract the greatest possible number of heat units from the oil? The oil is admitted to the fire-box by means of a burner placed in the front end of the fire-pan near the front end of the fire-box. This burner has two chambers or passages through it, one above the other, the oil flowing by gravity through the upper chamber and steam admitted through the lower. This steam is used for two purposes, one of which is to force the oil to the rear end of the fire-box against the flash-wall, the other is to atomize or break it up so as that it will fill the fire-box and mix the air that is mostly admitted in the rear of the box just in front of the flash-wall. This flash-wall is built up in front of the door and door-sheet to a height about even with the bottom of the fire-door.

As to the proper amount of air openings, it is understood that this depends on the size of the locomotive (that is, the fire-box area), and is determined in different ways. Some figure it according to the area of flue openings, making the air intake to the fire-pan equal to 40% or 45% of flue openings; and in other ways by the area by volume of cylinders, the figure .027 times the volume of one cylinder is used; as an illustration, for a 25 x 28 in. cylinder Pacific type passenger engine this amounts to 370 sq. in. It has been found, however, that engines equipped with this amount of air openings in the fire-pan made considerable gas and smoke if an excess of oil was used by the slightest opening of the firing valve, and in order to avoid this and produce better combustion the air openings were increased by cutting an opening on each side of the fire-pan 5 in. wide and 10 in. long near the bottom of the fire-pan, just forward of the regular air opening in the rear of the pan. This made an addition of about 100 sq. in. added to the rule for proper air openings on the size of engines referred to, or increased this air opening from 370 to 470 sq. in. By using this addition of air openings on larger engines in proportion to what they formerly had, as figured by this rule, it not only increased the steaming qualities of the engine, but decreased the fuel consumption. Still another formula is to take the volume of one cylinder (thas is, its diameter multiplied by the stroke), then use 2.7% of the total for the air openings in the fire-pan, dividing this in the proportion of 15% around the burner and 85% in bottom of the rear end of the fire-pan.

The air openings around the burner vary in size; however, we find openings of 6 in. x 8 in. x 10 in. give very satisfactory results, and the burner should fit in the middle of the opening, so that the bottom of the burner will be about 4 in. above the floor of the fire-pan and lined so it will be perfectly straight and the oil will not strike either the floor or sides of the fire-pan. This opening around the burner not only serves the purpose of admitting air around to keep it from overheating, but it assists in furnishing some of the air to support combustion. The regular or standard air opening is placed in the rear and bottom of the fire-pan so that the back edge of it will be some six to eight inches in front of the flash-wall and the size of this opening is worked out as previously mentioned. It is understood, there is no netting or baffle plates applied in the smoke-arches of oil-burning engines, and from what we can learn, about the same sized nozzle is used in an oil-burner that would be used in the same class of engine burning a good grade of bituminous coal.

In oil-burning locomotives the utmost care must be given to the brick work, for the reason that the least obstacle in the fire-pan often causes a restricted spread of the flame, which also causes a formation of carbon on the floor of the fire-pan. This deposit will increase in size in a short space of time, making a very hard-steaming engine and one that is wasteful of fuel, and in many cases this carbon has to be removed while on the road by the aid of a slash bar. Tests demonstrated that the use of interlocking brick has practically eliminated troubles of this kind caused by falling bricks. Another feature is that the fire-pan must be absolutely air-tight, that is, it must fit up so tight around the bottom of the mud-ring that there can be no possible chance for an air leak around it that can pass up between the fire-brick and the side-sheets, as this not only has a cooling effect on the side-sheets, but is detrimental to the brick work.

It is just as important that the proper amount of air be admitted in the right way to an oil-burning locomotive as it is to a coal-burning locomotive, and as formerly stated in this paper, draft means a current of air, and as air is the only thing connected with the operation of a locomotive that costs nothing and is the blood stream and life-giving element of combustion, your committee firmly believes the judicious use and control of it is essential and of the most importance in drafting locomotives to increase their efficiency and economy in coal and oil fuels.

The report was rendered by a committee consisting of J. D. Heyburn, master mechanic, St. Louis-San Francisco; J. S. Simino, road foreman of engines, Southern Pacific; E. A. Boa, road foreman of engines, New York Central; G. W. Coyle, Baltimore & Ohio, and D. Meadows, assistant division master mechanic, Michigan Central.

Traveling Engineers' Association reports continued on page 301.

Estimated Cost of Stopping and Starting Trains

By O. O. CARR, Statistician, Illinois Central R.R.

A study showing the cost of stopping and starting trains should be useful information for all employees, from the section foreman to those directly or indirectly responsible for economical operation. Such a study will supply a basis for constructive suggestions whereby train stoppages may be avoided by various improvements in operating facilities. A section foreman who knows these costs can better appreciate the real loss to the company as a result of stopping or slowing down trains on account of track work or other reasons. The cost of a 10-mile-per-hour slow down is almost equal to that of a stop. Likewise signalmen would be more impressed with the matter of avoiding stopping of trains, operators in delivering 19 orders, and those authorized to stop heavy through passenger trains to let off or take on passengers. The gross revenue from a 20-mile passenger fare is required to equal the cost of the stop.

A study of stopping costs will also show the advisability of curtailing flag stops, and making flag stops out of as many regular timetable stops as possible.

Arriving at the cost to stop and start trains the usual selected accounts, or unit of train costs per mile or minute, and applying to the actual time lost by reason of making the stop, is not representative, as there is no additional expense created for wages of crew unless they be on overtime, neither would there be any additional expense for roundhouse supplies, roundhouse men, or train supplies. There may be a small additional cost for locomotive and car repairs, over and above brake shoe wear, but under ordinary conditions this expense would be very small and difficult to determine definitely.

The cost to stop and start trains varies according to whether the start is made on heavy grade, curve or level track, and upon weather conditions, size of locomotives, number of cars and tons in the train, price of fuel delivered on tender, and other items, the determination of which would require a large number of tests to cover each condition. It is not infrequent for a freight train to meet with an unexpected stop, where the loss of nine minutes may be the direct cause of one to two hours' delay further down the line, because by reason of this stop it is not able to make the meeting and passing points lined up for it, in which event the cost of the stop would be much more.

A cost which covers operation under favorable conditions would seem to be representative for general requirements. For this purpose a series of tests and checks were made with the dynamometer car in connection with other tests being made at the time. Tests were made on approximately level straight track and under favorable weather conditions. Calculations were made of time lost taken from the time the locomotive was shut off to make the stop, to the time a speed was regained, after starting, equal to what the speed would have been had the stop not been made, plus the standing time it would have taken to have covered the entire distance if stop had not been made.

Tests were made with a freight train of the average train load, and a 2-8-2 type locomotive running at a speed of 25 miles per hour. The average stop was made in 1,980 ft., approximately 15 telegraph poles, in 114 seconds. If a stop had not been made this 0.375 mile would have been covered in 54 seconds, making a loss of 60 seconds. The calculations assume that 69 seconds is lost at the stopping point releasing air for the start. On these tests it required 15 minutes and a run of 3.4 miles from starting point before a constant speed of 25 miles per hour was attained. If the stop had not been made, the 3.4 miles would have been covered in 489 seconds at 25 miles per hour, or a loss of 411 seconds, a total loss of 9 minutes, by reason of making the stop. The time required to make this stop represents average anticipated stops; train control test stops, or emergency stops may show less.

Tests were made on a passenger train of eleven cars, handled by a Pacific type locomotive, running 50 miles per hour. From the time the locomotive was shut off, stops were made on an average in 2,344 feet, approximately 18 telegraph poles, of 0.44 mile in one minute. If stop had not been made, the same distance at 50 miles per hour would have been covered in 32 seconds, a loss of 28 seconds. Calculations assume that one minute was lost standing loading passengers and baggage. The train ran an average of two miles in four minutes from starting point before a constant speed of 50 miles per hour was attained. If the stop had not been made, this two miles would have been covered in 144 seconds, 2.4 minutes, which represents a loss of 96 seconds, or a total loss of 184 seconds, approximately three minutes by reason of the stop.

The additional coal consumed was arrived at by scoop count, based on $4.07 per ton delivered on tender, which includes both transportation and coal chute costs. Additional water costs are apportioned on the same ratio as the fuel was increased.

The locomotive and car brake shoe wear was based on elaborate tests made to ascertain the life of a brake shoe, and applied to locomotives and car costs according to the number of shoes on the test trains. Experiments have shown that wear on the wheel itself under action of most types of brake shoes, is exceedingly small, and would not materially affect these costs.

Superheat oil was based on cost per minute, from the average cost and consumption over a train district. It was assumed that superheat oil is feeding during a short time while the locomotive is standing, the same as when running.

The cost for per diem on foreign cars was based on $1.00 per day, and the same amount applied to owned cars, as the net earnings of a car per day approximates this figure.

The accompanying tables have been made up by using the items of cost as explained above and include only the items mentioned. As previously stated, it is not believed that it is proper to include many items ordinarily used in arriving at the cost of stopping trains.

ESTIMATED ADDITIONAL COSTS TO STOP AND START TRAINS

	Mikado locomotive with avg. train load 9 min. lost.	Pacific type locomotive heavy through passenger train 3 min. lost.
Coal (343 addl. lbs. frt—290 passgr)	$0.696	$0.602
Water	.046	.034
Brake shoe wear locomotive	.0049	.0037
Brake shoe wear on 50 cars and tender	.052	.0192
Superheat oil	.0029	.0023
Per diem or net earning capacity of 50 cars	.31	
Total cost non-overtime train	1.1118	.6612
If train crew is on overtime add 9 minutes overtime wages at $0.0855 per minute	.769	
Total cost overtime train	1.8808	

The tests having been made with a 2-8-2 locomotive, they are not a representative cost for a larger locomotive and train, but on the basis of above costs applied to a 2-10-2 class locomotive handling the average train load, the cost would be approximately as follows:

	2-10-2 type locomotive with avg. train load. 9 min. lost.
Fuel (550 additional pounds)	$1.116
Water	.073
Brake shoe wear locomotive	.0062
Brake shoe wear, 80 cars and tender	.0832
Superheat oil	.0046
Per diem or earning capacity on 80 cars	.50
Total cost non-overtime train	1.783
If train and engine crew are on overtime add 9 minutes overtime wages at $0.0857 per minute	.7713
Total cost of overtime train	$2.5543

Traveling in the Forties

An article in the *Saturday Evening Post* on the "Fabulous Forties" devotes a few paragraphs to a description of the methods of traveling that would have been followed by a bride on her honeymoon trip in the forties of the last century. Had Niagara Falls been her destination the published instructions were:

"Proceed direct, after you arrive at Albany, to Syracuse by railroad. This will occupy but eight hours. At Syracuse take the packet boats—by way of relief from car travel—from Syracuse to Oswego; the most beautiful scenery will reward your selection, and in five hours you are at Oswego. Here embark on board of one of the splendid steamboats, United States or St. Lawrence—floating palaces. After a plentiful repast and a sound sleep, at seven in the morning you will find yourself, refreshed, at Lewiston on the Niagara River, where there is a railroad and commodious cars waiting to convey you to Niagara Falls to breakfast. Thus, without trouble, delay, or any of the usual perplexities incident to travel, you arrive at the Falls in twenty-four hours after you leave Albany—and without the least fatigue."

And from New York to Albany she might, in summer, go up the Hudson by boat, and then travel by the Red Bird Line of coaches. Or she might go by boat to New Haven, then by rail to Hartford, then by stage to Springfield, then by rail again to Greenbush, and finally ferry across to Albany. Or she might prefer to take the boat to Bridgeport, and then proceed to Greenbush by the New York and Housatonic Railroad—in cars that resembled small omnibuses, separate ones for the ladies and gentlemen, with crosswise seats and a narrow corridor up the center, in the middle of which they kept the stove in winter—trundling along the single track, crossing turnpikes under wooden arches on which was painted "When the bell rings look out for locomotives." In 1843 the remainder of the journey to Buffalo was easier already, as it was possible to go all the way by rail for ten dollars, with only six changes of cars in twenty-five hours.

If she went visiting, in the very early 40's, to Boston, for instance, she traveled by boat, rail and stage from New York to Springfield, and thence by rail to her destination, or by boat and rail via Providence. A journey from New York to Philadelphia by rail and over two ferries required six hours. In fourteen hours, with a two-hour wait in Philadelphia, she could reach Baltimore. Richmond was thirty-six hours, Charleston eighty-eight hours and Mobile one hundred and sixty-three hours distant from New York. A trip to New Orleans by way of the "West" consumed twelve days and twenty hours—New York to Baltimore by rail, fourteen hours; Baltimore to Columbus by rail, and Columbus to Wheeling by mail chariot over the Cumberland Road, forty-four hours. Wheeling to the Ohio side by ferry, and thence to Cincinnati via Columbus, fifty-nine hours, including two stops of six hours each; Cincinnati to Louisville by boat, twelve hours; Louisville to Natchez by boat, one hundred and forty-nine hours; Natchez to New Orleans by boat, thirty hours.

One could ride in the great Mississippi River steamboats, which were at the height of their prosperity in this decade—four hundred and fifty of them in 1842, representing a value of more than seven million dollars. In the Yorktown, perhaps, with her twenty-eight-foot wheels, her four boilers and her forty private cabins. Or in the J. M. White with her wheel beams set back and her record-breaking run of three days, twenty-three hours and nine minutes from New Orleans to St. Louis—tearing along the river with the boilers at white heat from the pine and resin fuel, to beat another packet to the landing. Or, on the Ohio River, in the Messenger, in a tiny stateroom opening onto the ladies' cabin, if possible at the stern "because the steamboats generally blew up forward."

"Nothing but a long, black, ugly roof," as Mr. Dickens saw it, "covered with burnt-out feathery sparks, above which tower two iron chimneys and a hoarse escape valve, and a glass steerage house. . . . Within there is one long, narrow cabin the whole length of the boat, from which the staterooms open on both sides. A small portion of it at the stern is partitioned off for the ladies, and the bar is at the opposite extreme. There is a long table down the center and at either end a stove. The washing apparatus is forward on the deck. . . . At each"—of the meals—"there are a great many small dishes and plates upon the table with very little in them; so there is seldom really more than a joint, except for those who fancy slices of beet root, shreds of dried beef, complicated entanglements of yellow pickle, maize, Indian corn, apple sauce and pumpkin."

If she had occasion to go from Harrisburg to Pittsburgh, she traveled in a canal boat, "a barge," according to Mr. Dickens, "with a little house in it, viewed from the outside, and a caravan at a fair, viewed from within—the gentlemen being accommodated as the spectators usually are in one of those locomotive museums, and the ladies being partitioned off by a red curtain." There were three horses to draw the barge, and a very small deck space in which everyone contrived to "lie down nearly flat" when the helmman cried "Low bridge!" The lowceilinged cabin contained a stove, a row of little tables down both sides, and some thirty male passengers. On either side of the cabin there were three long tiers of suspended shelves, with a sheet and a blanket apiece, for which the occupants drew lots at nightfall. "As to the ladies, they were already abed, behind the red curtain, though as every cough or sneeze or whisper behind the curtain was perfectly audible before it, we had still a lively consciousness of their society. . . . All night long, and every night, on this canal, there was a perfect storm and tempest of spitting."

There was a tin ladle chained to the deck, with which "those who cared about washing" fished water out of the canal and poured it into a similarly captive tin basin. There was also a jack towel, and in the bar a mirror and a public comb and brush. For breakfast, dinner and supper there were tea, coffee, bread, butter, salmon, shad, liver, steak, potatoes, pickles, ham, chops, black pudding and sausages.

At the foot of the mountains the canal stopped and passengers were conveyed across by "land carriage," on the Portage Railway. "There are ten inclined planes," Mr. Dickens found; "five ascending and five descending; the carriages are dragged up the former, and let slowly down the latter, by means of stationary engines; the comparatively level spaces between being traversed sometimes by horse and sometimes by engine power. . . . Occasionally the rail are laid upon the extreme verge of a giddy precipice."

And they were enormously and justly proud of it, and traveled by the thousand over it.

Cost of Rolling Equipment Now Double That of 1914

If a dollar bill would have paid for a complete locomotive in any of the years between 1910 and 1914, that same locomotive during the year 1924 would have cost $2.16. If that same dollar bill would have paid for a steel freight car during the period 1910 to 1914, that car in 1924 would have cost $1.96. A composite wood and steel freight car which would have cost a dollar in the normal years between 1910 and 1914 would also have cost $1.96 in the year 1924.

These are some of the contrasts in railroad equipment costs revealed in a report issued by the Presidents' Conference Committee of the Eastern Railroads.

The report, which also deals woth wood freight cars and all steel passenger trains, shows the following:

Assuming that an all wood freight car in the 1910-1914 period cost one dollar, in 1924 the cost to the railroads for that same car was $1.82 and an all steel passenger train car which under the same comparison would have cost $1.00 in the 1910-1914 period, cost $1.94 in 1924.

The report discloses that these figures on rolling equipment are based on the total selling price of the entire output of two large locomotive and seven large car companies with locomotives and cars sold to foreign countries excluded.

More Equipment Being Ordered

An idea of what this means in increased costs to the railroads is gained by a further examination of the report which shows that these same plants, which during the 1910-1914 period delivered 10,583 locomotives, increased their deliveries to the railroads during the ten-year period following to more than 13,000 additional locomotives.

PERCENTAGE OF INCREASE IN COST OF RAILWAY EQUIPMENT OVER 1910-1914

	Locomotives	Freight Cars All Steel	Freight Cars Composite Wood and Steel	Freight Cars All Wood	All Steel Passenger Train Cars
1915 ..	same	2	1	D 7	D 11
1916 ..	43	56	46	41	5
1917 ..	110	99	69	101	35
1918 ..	106	147	153	153	69
1919 ..	112	165	182	182	105
1920 ..	158	174	198	198	131
1921 ..	116	75	97	97	63
1922 ..	102	56	75	75	60
1923 ..	124	103	109	101	94
1924 ..	116	96	96	82	94

D—decrease.

Note:—This data is based on the total selling price of the entire output of two large locomotive and seven large car companies with certain sales excluded such as the Pershing locomotives and locomotives and cars sold to foreign countries.

And the railroads which purchased 71,108 all steel freight cars from these same plants in the years 1910 to 1914, placed orders for 167,659 cars of this type during the ten years following.

What this means in dollars and cents is illustrated by some average costs for 1924. The average locomotive cost $65,000, an average steel freight car cost $2,100, and an all steel passenger train car cost $25,000.

Use of All Wood Freight Cars Declining

The decline in the use of all wood freight cars is best indicated by the same report which shows deliveries to the railroads by these plants of 53,349 cars of this type during the first period, 1910 to 1914, and only 28,541 during 1915 to 1924.

Railroads, in common with other industries, as these figures show, have had to carry and are carrying their share of the increased costs in labor and material which are the large factors in these costs. Although the figures for 1925 are not yet complete there is the indication that they may show a slight decline in costs of rolling stock as compared to 1924.

The following table shows the percentage of increase in the cost of locomotives and cars over the average price of the period 1910-1914. This period is considered as normal and the average price has been put at 100.

Electrification Saves Double Tracking of African Railroad

The largest automatically equipped railroad electrification in the world has been installed on the Natal main line of the South African Railways. The road experienced such an increase in business that extensions of facilities became imperative. There was a choice between double tracking or electrification, and the engineers decided to electrify for a distance of 171 miles, between Glencoe Junction and Pietermaritzburg. This is the first railway electrification in South Africa, and is being followed by the electrification of the Capetown Suburban lines.

Twelve 3000-volt automatic substations were required in electrifying the railroad. Standard three-unit sets of 2000-kw. capacity are used in all stations; four stations being equipped with one machine each, seven with two machines, and one with three machines. The power is generated at Colenso, 112 miles from Pietermaritzburg. The station equipment includes five turbo-generator sets, each with a continuous rated output of 12,000 kw. at 6600 volts, three phase, 50 cycles. Transmission is at 88,000 volts. At the substations the power is reduced to 6600 volts and converted to 3000 volts direct current by the synchronous motor-generators. Provision is made for the operation of all these sets inverted, in case the regenerated current from the locomotives exceeds the requirements of other trains taking power. The average substation spacing is 15½ miles, and there is practically no stub-end feed since a substation is located at both Glencoe and Pietermaritzburg. The substation was furnished jointly by the British Thomson-Houston Company and the International General Electric Company. Each of the automatic equipments is designed for local and remote control.

The reports of Merz & McLellan, the consulting engineers who recommended electrification rather than double tracking the Natal lines, emphasized several advantages to be gained thereby, as follows:

Electrification required no more time than would have double tracking.

The net capital outlay was small when compared with the annual saving in working expenses resulting from electrification.

There are several tunnels, some very long and one or more through which it would not be feasible to double head steam trains.

Electrification eliminated the danger of grass fires and the expenses thereby entailed in applying fire breaks outside the fence.

Short adjoining lines can be electrified at comparatively small expense. Many of these branch lines have severe grades and are difficult to operate with steam equipment.

Fewer trains and more uniform speeds are possible.

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Voluntary or Compulsory Railway Mergers?

During the past year or two we have heard much of railway mergers and the great economies that are claimed will result therefrom. In fact, some advocates have gone so far as to claim that the merging of all our railway transportation lines into a very limited number of big systems would automatically effect such wonderful economies in the cost of transportation that there could at once be made a drastic reduction in both passenger and freight rates, and a wonderful increase in net profits for distribution among shareholders. Therefore, if those in positions of authority do not act voluntarily, then compulsory measures should be invoked without further delay. To those who hold such views and are more or less active in its dissemination, we beg to intrude the suggestion that they lack knowledge of the fundamental principles involved, or are personally interested in certain merger deals, the successful consummation of which would operate to their benefit in a financial way.

There are certain features in regard to railway mergers that have been grossly misrepresented to the masses by those who are ignorant of the real facts or are actuated by wholly personal interests of a financial character.

One of the fundamental features involved in this merger question, which is overlooked or ignored by many who so strongly urge quick action, is the universally recognized principle in all honorable business transactions of property value, and its protection under our Constitution by the "Due Process of Law" provision, which is adhered to by all those who stand committed to the square deal principle in business transactions, but which is almost invariably evaded, if possible, by those who have a financial ax to grind.

Our courts of last resort have long ago wisely ruled, that it be set down as a fixed principle recognized by law, that: *"a fair price for anything is a price agreed upon between a willing seller and a willing buyer."*

Any forced sale, merger or exchange of property under conditions other than the foregoing, should be, and in all probability would be held by our courts as having violated the Constitutional rights of either party objecting to the conditions imposed, and it is therefore very welcome and refreshing news to those railway executives and owners who are opposed to undesirable mergers, that would in all probability have an adverse effect on their property and result in no benefit to the public, to learn through press dispatches that President Coolidge (if correctly quoted) is favorable to making all haste possible in the directions of voluntary groupings, as more preferable to compulsory mergers.

There are now about 22,000 miles of railway in the hands of the courts that will be finally auctioned off to the highest bidder at receivership sale, while there are thousands more that are not much better situated.

Not all, but some of this mileage was originally built for the sole purpose of eventual sale to some one of the financially stronger and more prosperous lines in the territory served, and it is worthy of note that owners of these weak lines are strong for compulsory mergers with the stronger lines. In fact, as a result of operating deficits and failure to find a willing buyer for some of these properties, at most any price, has prompted the owners to request the Interstate Commerce Commission for authority to surrender their charter, abandon their line, and junk or salvage such integral parts as may have a scrap value. These stronger lines in many cases do not want to risk impairment of their financial structure by taking over what some have termed "weak sisters," which might under certain general adverse railway conditions be too great a burden for them to carry. Such mergers would work great hardship on the stronger line and not benefit the public, except those who as individuals would profit financially through their consummation, quite a few of which are now being strongly urged.

Many of those advocating consolidations as the solution for reduction in the cost of transportation have overlooked or ignored the controlling factors that regulate railway rates.

The principal expenses of transportation are labor, fuel, material, supplies, and taxes, which mergers will *not* reduce. No one with even an elementary knowledge of the subject will contend for one minute that consolidations or mergers will effect any reduction in these items, except possibly in a few instances where the salary of one or two executives might be slightly reduced by the substitution of a vice-president at a few thousand dollars per year less. Even such saving as may be effected in this manner would be hard to find with a highly magnifying glass, when reduced to or allocated with the *unit cost* per ton of freight or passenger handled.

To be more specific and as a hypothetical case let us assume that the following lines were merged; Chicago & Northwestern, Union Pacific, and Central Pacific, thus making an unbroken line under one president from Chicago to San Francisco, 2,261 miles, and a total mileage of about 13,000.

It is safe to say that a ton of freight or a passenger could not be transported for any less expense, or more expeditiously than at present under three presidents. There are other instances wherein consolidations or mergers would make it possible to save much time and some expense in the maintenance of equipment or rerouting of tonnage over shorter or lighter grade lines. But, in some of these cases diverting the bulk of traffic from an established line may have the effect of depreciating the value of its securities and thereby endanger the financial structure of an otherwise financially sound and well managed property, the shareholders of which are not only entitled to consideration, but will no doubt, if forced into a compulsory merger, invoke the protection of our courts in properly safeguarding the property entrusted to their care and keeping.

There are about................	850,000 shareholders
And	900,000 bondholders
A total number of railway security holders of..........	1,750,000
Savings banks have invested in railway securities about	$1,000,000,000.00
Life insurance companies............	1,900,000,000.00
A total of approximately..........	$2,900,000,000.00

From the foregoing it must be clear to any fair minded person that all those who wish to aid in strengthening the stability of our institutions will bend their energies toward effecting voluntary consolidations of demonstrated far as possible, compulsory mergers.

The Whistle

Dr. A. L. Foley of the University of Indiana has recently made some interesting investigations as to the efficiency and cost of operation of the locomotive whistle. This question of "how much does it cost to blow the whistle," is not a new one. It must have been twenty-five years ago that Angus Sinclair, editor of this paper, made a crude investigation of the subject, and reached the conclusion that it was a rather expensive luxury.

The immediate cause of Dr. Foley's investigation was a crossing accident on the Pennsylvania Railroad where an omnibus filled with school children was struck in a dense fog, although the driver had stopped and gone upon the track to look and listen and yet had not heard the usual crossing signal that had been sounded. The general results have been simply confirmatory of what every observer has known for years, and that is that the sounds made by a moving train are much more audible and are louder, off at the sides than they are immediately in front or behind. The rule of using the left hand truck so as to be able to see an approaching train instead of having it sneak down upon one from behind is based upon this fact. This can be tested by facing an approaching train on a long tangent track and noting how near it can come before its noise is appreciable, while at a half mile or more distance at the side, its roar can be heard for a long distance on either side of the observer. And this holds true of the sound of the whistle, bell and ring of the side rods of a drifting locomotive as well as of the general rumble produced by the action of the wheels on the rails.

Prof. Foley attributes this in the case of the whistle to the interference of the dome and the smoke-stack, which of course does have its effect. Perhaps the wheels in front interfere with the transmission of the sound made by the wheels at the back. But whatever the cause the well-known fact remains that the appreciable noise of an approaching train is at its minimum directly in front of it.

To remedy this condition, it is purposed to place the whistle in front of a parabolic reflector, that shall have the combined effect of a sounding board and a megaphone, whereby the sound vibrations shall be intensified and projected to the front. This might be of assistance to those directly in front of the train but might easily be so concentrated as to render the blast inaudible to one approaching the track from the side, and who was outside the cone of projection at the moment a crossing signal was sounded. The suggestion is, however, well worth a trial because it is certainly desirable that some of the noise which is now dissipated over the countryside should be thrown to the front where it can serve as a useful warning of approaching danger.

Another interesting feature of the investigation is the cost of whistling that it developed. It appears that the particular whistle that was used required the steam generated from 8,000 lbs. of water, to keep it in operation for an hour, and an estimate has been made that, scattered over the railroads of the country, we are paying eight million dollars a year to blow our horn.

The investigator suggests the standardization of the pitch of the locomotive whistle of the country several octaves higher than the pitch in common use, because the human ear is more sensitive to a higher frequency of vibration than to a lower. More sensitive yes, because the higher frequency calls for a more rapid response by the auditory nerves, which in the case of a file or very highly pitched whistle may grate upon the nerves. But it must also be borne in mind that these high frequency vibrations have less penetrating qualities and die out long before their lower toned brethren. This is recognized by the lighthouse board by its adoption of low pitches for its sirens whose blasts must be made audible at maximum distances, and by the invariable use of low toned whistles on steam vessels for the same reason. It is improbable that the blast of a steam whistle "several octaves higher" than that of the average whistle could be heard at a crossing 800 or 1,000 feet away, while for a station signal it would probably be quite useless. But if anything can be done either in the way of a reflector-megaphone or other means, to cut off the noise of a whistle from those points of the compass where it is a nuisance and place it where it is needed, it will receive a hearty good speed from all.

Traveling Engineers' Association

The thirty-third annual convention of the Traveling Engineers' Association, which was held in Chicago last month, was the most successful meeting held by that highly useful organization.

The duty and purpose of the Association is, "to improve the locomotive engine service of American railroads," and the excellent work the organization is doing every year is reflected in the committee reports and the practical ideas they bring forth in the discussions and introduce in railway service.

Elsewhere in the present issue of this paper we publish some of the papers presented at the last convention.

Handling Locomotive and Air Brakes

In the paper "Loss, Damage and Discomfit Due to Improper Handling of Air Brakes," the committee has considered questions involving the design, maintenance and operation of brakes. Too much stress cannot be laid on the importance of proper maintenance and lubrication of triple valves. If the triples are properly cleaned and maintained they do not dynamite, kick or grab and trouble in their operation is generally due to lack of proper maintenance or failure to clean and oil rather than any defect in the valves themselves.

Piston Travel and Leaky Pistons

The Committee has stated in the fewest words possible the fundamental facts and principles that should form the basis for removal of complaints on this score by providing proper maintenance of this most important part of power brakes. A railway mechanical officer who paid as little attention to leaky pistons and piston travel in locomotives as is accorded air brake cylinders would be considered incompetent or crazy if not both, yet the principle involved is the same, although the apparent results are more pronounced in the former.

The campaign on this question of maintenance should not even let up, until uneven piston travel, leaky pistons and faulty triple valves, will through lack of proper cleaning, repair or adjustment be as rare as similar defects in the best passenger engines.

Damage from Rough Handling

The report also deals with the damage from rough handling which aside from the question of brakes, their condition and handling introduces a subject in which a very broad question of operating policy is encountered and on which volumes have been written and spoken by technical and practical students and is still far from solution.

The statement has been made by experts that 80 per cent of the cost of repairs and maintenance of freight cars is due to rough handling and 20 per cent to actual wear from servise. Rough handling or abuse is the cause of much of the cost of car repairs, and shortening their otherwise normal life. We are inclined to think, however, that 80 per cent is too high and that 50 per cent would be a safer and more conservative figure, and based on this estimate the possible saving may be computed.

The complete maintenance of freight equipment for the year 1923 which includes depreciation and retirement charges was $596,391,610.

If 80 per cent of this was due to rough handling or abuse then the excess expense over normal wear would be $477,117,288. If 50 per cent is due to rough handling or abuse then the excess expense over normal wear and tear would be about $298,195,805. If all railways would handle their freight equipment as carefully as they now handle their passenger equipment it would, we think, be within the bounds of conservation to estimate the saving at 50 per cent over the present cost.

Such a radical change as suggested is improbable and to some extent impossible and therefore cannot be expected. It has been conservatively estimated, however, that without interfering with prompt movement of traffic that one half or 50 per cent of this expense could be saved by a more careful handling of freight equipment both in yards, terminals and on line of road, and in the latter branch of service the traveling engineer is an important factor.

On the latter estimate the amount of possible saving would be 50 per cent of $298,195,805 or $149,097,902. In addition to the foregoing our railways have paid out during the past six years on loss and damage claims $517,680,277, and while these claims have been reduced to less than $50,000,000 per year, it is an expense closely related to rough handling and any reforms or improvement in the latter will automatically serve to reduce the former.

Draft Gear as a Factor

That section of the report dealing with the measured impact of equipment coming in contact at various speeds, together with graphic charts of impacts, are very interesting. Traveling engineers are of course more interested in the question of train brakes and their operation than in draft gears, although the latter plays a much more important part in train operation than most people think.

As an example, consider a freight train of 100 cars in good average condition. Draft gears are designed for 2-9/16 in. to 2¾ in. travel; there is always ⅜ in. or more lost motion, play or tolerance in draft lug spacing, knuckle pins, knuckle faces, etc., so that 3 in. travel or play may be figured as the minimum or 6 in. between cars, so at the 80th car we have 40 ft. of slack and at rear of 100th car 50 ft. of slack, so that 80 per cent of a train is under way before the 81st car moves, then is it any wonder that the rear end of heavy tonnage train, loaded to full engine capacity, have the rear ends snapped off in starting? It is surprising that there are not more accidents of this kind, and through no fault of the engineer.

There are also other conditions which tend to aggravate the above situation and there is very little effort being made to remedy the trouble. Among the different types of draft gears in use, particularly friction gears, in many of them lost motion increases rapidly with service, so that in a short time a gear with no broken or lost parts will travel ¾ to 1 in. and in many cases 1¼ ins. before it begins to function at all, so that there are hundreds of thousands of cars with gears that have only 1¾ in. in which to absorb the shock, jerk, or blow which is frequently in excess of the capacity of the gear if it had the full 2¾ in. travel in which to function. Gears in this latter condition would afford very little if any protection to the draft line of cars at a speed of 2 miles per hour.

Then again there are some friction gears that when struck a hard blow are driven home solidly locked, and do not release, thus leaving the car with no gear of any kind, but 2¾ in. or 3 in. play, or lost motion. In most trains of 100 cars or more, there will be some cars of the two latter descriptions that will aggravate the conditions first described in that the slack of 40 and 50 ft. will be increased, and the defective gears instead being an aid in starting the train, contribute to its failure.

Friction gears are theoretically intended to protect both cars and contents from the adverse effects or recoil action of stored up energy in compression spring when in release action, and while all of them do this in laboratory tests, they must be made so as to function at all times in the release movement in actual operating service.

There is a wonderful field for missionary work among those who through acts of omission or commission are responsible for the excessive expenses resulting from rough handling and destructive abuse of freight equipment and contents, and in this work the traveling engineer will, as in the past, play a most conspicuous part.

Carbonization of Lubricants

Since the superheater has been with us, we have been told so many times by traveling engineers and others in authority that when we close the throttle on a locomotive equipped with a superheater, at the time the cylinder temperature is higher than the "flash point" of the lubricant, that when the air is drawn into the cylinders the oil flashes and the result is carbon deposits. The last discussion the writer listened to prompted him in making a laboratory test to prove to all concerned that this is a misleading theory and contrary to the laws of combustion.

The test proves that it is not the air which destroys the lubrication but the partial-vacuum which is created by the receding pistons at the time the cylinder temperature is above the "flash point" of lubricant used. It was proved that a very rapid state of distillation or vaporization takes place, and all the vaporous constituents contained in the oil are distilled off, and, the carbon being the solid in the oil remains.

The thick gum often found on piston-rods is the result of distillation, the locomotive having been brought to a stop too soon to reduce oil to carbon; the blue vapor often seen expelled from the stack instantly after the throttle is closed is the result of distillation and not combustion. That blue-vapor indicates that the oil is being destroyed by the partial-vacuum and temperatures higher than its "flash point."

It requires a flame or spark with a temperature of 1100 to 1200 degrees F., to burn the vapor created in the cylinders of a locomotive, and then only in the presence of atmospheric-oxygen.

Oil does not burn as oil, and gasoline, as inflammable as it is, does not burn as gasoline; both the oil and the gasoline must be vaporized and mixed with oxygen of suitable proportions. Liquids do not burn as liquids nor does coal burn as coal.

Cold water will boil under the influence of a complete vacuum, so one can readily see what the effect of a partial-vacuum will have on a lubricant when subjected to temperatures higher than its "flash point."

We have been told to use the "drifting throttle," to prevent the admission of air to the cylinders at the time cylinder-temperature is higher than the "flash point" of lubricant as the air flashes the oil and causes carbon. This is a misleading theory and demonstrates the fact that it has been accepted because somebody started it who was supposed to know; we too often accept the arguments of some men without thinking, and too many men take advantage of the ignorance of their listeners.

Any one who will study combustion or understand it, will find that the lubrication is destroyed before the air gets into the cylinders though a flash did take place.

The writer found that the purpose of the "drifting throttle" is to fill the vacuum and assist in cooling the cylinders. A great many engineers do not use the "drifting throttle" because they do not believe that the air flashes the oil; but they do know that by all indications that something is destroying the lubrication and causing carbon, yet they do not reason the thing out.

We should go into this matter deeper than has been customary, as this theory has been the cause of a direct loss of millions of dollars to the railroads throughout the United States, by fuel losses due to blows and to delays to power held in for cylinder-packing because the "drifting throttle" had not been used; not used because our engineers had been mislead.

Where there is an effect such as we have been contending with for so many years, which results in serious damage and delay to power, we should not accept some worn-out theory someone hands down, but we should broaden out and search out the real cause of our difficulties and call things by the right name, and give our engineers the right information to work on, then we can expect co-operation. My former Superintendent of Motive Power, who was with the railroad for over half a century told the writer a theory had been reversed, and he did not accept my findings until after he had referred them to the company's Chief Engineer of Tests. The Chief Engineer's report was in accord with my report and many more points of interest were brought out.

One of the hardest things to get the majority of men to do is LISTEN AND THINK.

In conclusion, the writer feels he has reversed a theory of long standing, and one which has been given but little thought. If any of my readers feel in doubt as to what has been written the writer asks that they go to their laboratories and test it out.

In closing, will say with Demosthenes, "I BEG OF YOU TO THINK."

Fresno, Calif. H. J. Ogilvie.

We are pleased to serve as a medium through which students of the multiplicity of problems involved in the design, construction and operation of locomotives may exchange ideas. On the subject of lubrication, the author of the foregoing has as a result of his study of the matter reached conclusions not entirely in harmony with the more generally accepted beliefs and on account of the importance of the questions involved, we hope there may be a very free and frank response by those qualified to speak on the question, and to this end we invite contributions for presentation in the columns of Railway and Locomotive Engineering.—Ed.

Corrections

An error in the use of the words "per cent" appeared in the articles on "Working Capital Versus Idle Money or Frozen Accounts" in both the August and September issues.

On page 234 of August in the third and fourth paragraphs of the article referred to the ".0347" and the ".051 per cent" should have been "3.47" and "5.1 per cent" respectively.

On page 267 of the September issue, the decimal point in the column of the table headed "Per cent of Investm't" should be moved two points to the right in every case so that the figures should read 6.57, etc.

There is also a mistake in the total M. & S. & Cash for the C. R. I. & P. which should have been 14,948,243 instead of 24,948,243.

Increased Railway Efficiency

Operating efficiency of railroads in the United States has increased 25 per cent in the past five years, according to the Trade and Transportation Bulletin of LaSalle Extension University.

Freight traffic has increased 36.8 per cent and passenger traffic 4.5 per cent in that period, while operating expenses have been reduced more than $1,300,000,000 a year, the bulletin states. According to the National Industrial Conference Board the total operating expenses for Class I railroads in 1920 were $5,828,000,000 and in 1924 had been reduced to $4,509,000,000.

Outstanding instances of economy include coal efficiency, which has been increased 13.7 per cent. In 1920, 197 pounds of coal were required for each 1,000 gross freight ton miles. In 1924 the same result was accomplished with 170 pounds of coal. Loss and damage on Class I roads were reduced from $119,833,127 in 1920 to $41,380,000 in 1924.

These economies were not effected at the expense of the shipper, it is pointed out, as freight charges in the period from 1921 to 1924 were reduced to an extent saving shippers a total of $1,611,000,000 of the amount they would have had to pay had the 1921 freight rates remained in operation.

Coal Strike Costs Roads $3,500,000 a Week

Estimate of the loss of revenue, due to the coal strike, of the nine railroads engaged in handling anthracite coal has been placed at $3,500,000 a week. The carriers referred to are the Delaware & Hudson, Lehigh Valley, Lackawanna, Reading, Central R. R. of New Jersey, Lehigh & Hudson, Lehigh & New England and the Pennsylvania. The volume of traffic has been decreased 40,000 cars weekly.

The Virginian Begins Electric Operation

Ceremonies in Connection With Official Inauguration of Electric Service

Electric operation on the Virginian Railway was inaugurated on September 21. Four triple-motive power unit locomotives, comprising twelve of the 36 units included in the original order are now on the system and on Monday, September 21, the first official run was made. This electrification was briefly referred to and a description of the electric locomotives was published in the June, 1925, issue of RAILWAY AND LOCOMOTIVE ENGINEERING.

Tonnage trains are now operated from Mullens, W. Va., up the 2.07 per cent grade to Clark's Gap, W. Va., a distance of about 15 miles. At present four electric locomotives are being used on this grade. The overhead construction is completed for several miles beyond Princeton, W. Va., which is 36 miles from Mullens. When completed the electrified division will extend to Roanoke.

As a preliminary to placing the electric locomotives officially in revenue service a steam train of approximately 6,000 tons trailing load was hauled up the 2.07 per cent grade between Elmore and Clark's Gap on September 20th. In this operation the 2-8-8-2 road locomotive and two 2-10-10-2 pusher locomotives were used as in the regular service. The pusher locomotives are the heaviest ever built, and weigh 898,300 lb. The weight of the road engine is 740,100 lb. The run between the two points mentioned is made at the rate of about 7 miles an hour. An electric train with a similar trailing load was drawn by one of the electric locomotives of three-motive power units and pushed by a similar locomotive. The steam train was given a 15 minute start on the heavy grade but the electric locomotive train easily overtook the steam train long before the summit had been reached, a distance of about 15 miles. The electric locomotive operated at a uniform speed of 14 miles an hour.

On September 21st the final test run of the electric locomotives was made, also in competition with a steam propelled train, and included tests of stopping and starting this enormous train weight on the 2.07 per cent sections of the grade.

The electric locomotives were able to get away to a flying start without difficulty and to bring the speed up to 14 miles an hour well within the predetermined period of 3 minutes.

Signals for stopping and starting were transmitted from one locomotive to the other by radio and this proved to be a great convenience. Often a 6,000-ton train on the Virginian, when not comprised entirely of the 120-ton capacity cars, is nearly a mile long. As there is practically no point on the 2 per cent grade section where an entire train is on tangent track and but very few points where the two engines are in sight of each other, it is always difficult, and often impossible, for whistle signals to be heard. At one point there are two tunnels and a

International News Reel Photograph

Heavy Coal Train Drawn by Electric Locomotives Passing Similar Heavy Train Drawn by Steam Locomotives on the Virginian Railway

Underwood & Underwood Photograph

W. A. Gore, General Manager and J. W. Sasser, Superintendent of Motive Pcwer of the Virginian Railway and Miss Nancy Sasser, Who Christened the Electric Locomotive and F. H. Sheperd, Director of Heavy Traction of the Westinghouse Electric & Manufacturing Co.

long curve between the front and rear engines. Also, with trains including from 70 to 100 cars, depending upon car capacity, the "bump-back" system is not very satisfactory because of the great amount of slack in such a long train. It is believed, therefore, that the transmission of the signals by radio will prove to be of immense benefit.

When the test train reached Clark's Gap, at the top of the "hill," the leading locomotive was officially christened by Miss Nancy Sasser, daughter of J. W. Sasser, Superintendent of Motive Power of the Virginian, and was "turned over" by F. H. Shepard, Director of Heavy Traction of the Westinghouse Electric & Manufacturing Company to W. A. Gore, General Manager of the Virginian. Mr. Gore in turn "delivered" the locomotive to Mr. Sasser and on signal from the latter the train proceeded on its way, being started in "official" service by J. E. Sharpley, Electrical Engineer of the Virginian. A considerable number of visiting railroad men, newspaper, technical and radio editors and newspaper and weekly news reel moving picture operators were present to witness the placing in service of the mightiest locomotives in the world.

All of the heavy tonnage movement on the Virginian is east bound coal, and from the eastern end of the electrified section trains will be hauled to tidewater by steam locomotives in accordance with present practice. The grade favors practically the entire way and electric operation on this section is at present unnecessary.

Working Capital vs. Idle Money or Frozen Accounts

Third Article

By W. E. SYMONS

Among those who have read the two previous articles in Railway and Locomotive Engineering under the above caption and have favored us with comments of endorsement or criticism is one rather appreciative reader who disclaims any desire to be classed as "one of the doubting Thomas type" or to be considered so blind or deaf to good business methods or railway economics as to be a subject for the use of an official crowbar in order to pry open either his ears or eyes, but asks for more light on the subject.

The article in September issue of this paper,' after condemning the waste or misuse of companies' funds by the unnecessary purchase of material and supplies, and preaching a strong sermon on the Gospel of Economy in railway management in general, it was predicted in conclusion that those who accepted the proposition in principle and acted thereon, might safely be assured of the following results:

1. Those who have already put their house in order will stand endorsed.

2. Those who through acts of omission or commission are responsible for the investment of large sums of their employing company's funds in material or supplies that were either not needed or that will be a partial or total loss may meet with a mild rebuke, but the readjustment should not be longer delayed.

3. The release of this idle money will not only strengthen the financial position of such companies as are the greatest beneficiaries, but at the same time aid in preserving the integrity of the company's capital account.

This correspondent in making particular reference to the last or closing paragraph above quoted, asks how the suggested economy could strengthen the financial position of a railway company, and finally with almost brutal frankness asks: "what in the *Devil and Sam Walker* has this got to do with the integrity of the company's capital account?"

Both of these questions are quite easy to answer. In the first place, any corporation no matter if it be a railway or industrial concern that has several, or even *one million* dollars tied up idle that is not necessarily essential to the safe and economical operating of the company's business, is not in a strictly first class condition financially, and in case of lean years, or a marked reduction in volume of business or net income, a company so circumstanced would find difficulty in securing funds to tide over a period of depression, while others, in the same or similar line of industry but with no dead stocks, frozen accounts or idle money, would experience little or no embarrassment in financing their requirements.

Second: All material, supplies and other physical property, represents money or capital of the corporation which its officers have invested in material things, and if money so invested lies idle in a frozen account, unnecessarily depreciates in value—becoming a partial or total loss, or is not employed to yield a proper return on the original investment, then, and to the extent of such failure, depreciation or loss, the integrity of company's capital account has been impaired.

By way of illustration a few examples with a hypothetical case or two might serve to both clarify and emphasize the more salient points involved.

In the previous article on the subject there was cast up in tabulated form the operating mileage, investment in road and equipment (book value) cash on hand, material and supplies, average per mile of line, per cent of cash, material and supplies to investment in road and equipment, and operating ratio of 40 class 1 railways, with a total of 150,316 miles, and an investment in road and equipment of $14,482,230,418.00.

Employed in the operation of this property there was on hand at the time of filing report the following:

Cash on hand	$276,954,144
Material and supplies	498,873,451
Total................	$775,827,595

No one except certain officers of these companies or an expert who has made a careful study of the subject can say just how much these accounts *might* and *should* be reduced. Any one however, who has had the experience and made a careful unbiased study of the subject knows full well that, a good healthy housecleaning would yield many millions *from* the ledger account, without getting on what may be termed thin ice, in so far as having ample cash, material and supplies, is concerned.

In order to be on the side of conservatism let us assume that the cash account could safely be reduced 10 per cent or $27,695,414, and material and supplies 15 per cent or $74,831,017, a total of $102,526,431. This sum capitalized at 5 per cent would yield $5,126,321.00 per year on only 40 class 1 railways out of 183.

That this sum would aid materially in strengthening the carriers financial position and in the preservation of the integrity of their capital account cannot be denied. In checking up supplies or excess material and supplies, also the fixed property account some rather strange and amusing conditions are found, the explanations offered at times leaving one somewhat in doubt as to a fair division of responsibility among individuals and the customs, rules or habits, the combination of which operate to cause great loss in these items of expense.

Integrity of Capital Account

The rank and file of railway men are as a rule of the opinion that no matter what may happen to the company in a financial way, there is only about three men or officers who could by any stretch of imagination be in any way responsible for it, namely, President, Treasurer and Comptroller, and while it is true these three executives in co-operation with the board of directors shape the financial policy of the company, yet as a matter of fact the greatest wastes of funds through investment in material and supplies does not, as a rule, originate with any of these officers and in few cases do they either see or personally approve requisitions for purchases.

To better illustrate this feature, actual cases may be cited wherein failure to properly conserve investments in material and supplies or some integral part of the physical property effected to some degree the integrity of the company's capital account.

A certain railway became so badly run down physically and financially that it was forced into bankruptcy and the owners employed outside talent to investigate and report on its true condition, the causes responsible therefor, and make recommendations as to plans of rehabilitation.

The condition of equipment, permanent way, bridges, buildings, shops, round houses, depots and stations all indicated poverty and with one accord most every one simply said: "We have neither material or supplies, nor money or credit with which to stock up, and while this was true with respect to certain specific items, it was not true as to the property as a whole, nor of any one entire department.

At a fairly good sized and very busy interchange point, located some distance from a division terminal with round house, shops and division storekeeper, the car repair foreman who was also chief joint inspector had on hand more material and supplies than could be used in 25 years, while quite a fairly good percentage of it was for cars or parts that were obsolete and would never be used. Of the excess material that was usable large quantities were lying idle, rotting or rusting away, although engines and cars were held in shops at the division point less than 100 miles away awaiting for duplicates of this same material to be purchased and rushed by special fast freight or express.

It developed that there was excess material and supplies carried on the company's books for this point amounting to about $50,000. Much of it had been on hand 5 to 10 years, some of it could not be found, and that which could be checked up and identified, had an estimated value to the company of about $5,000. The company's ledger account of material and supplies at this comparatively small station had shrunk 90%, yet was still carried at its original or cost price—and now as to the cause of this condition.

The foreman at this heavy interchange point had been there many years and was a good man, but when first stationed there and while short of certain material there were several delays to important freight trains, the man was reprimanded several times on this account by both the transportation and mechanical departments, and finally told that he must have on hand enough material and supplies of every kind that might be used in any emergency, and if there were any more such delays to traffic he would be dismissed. He, at once, proceeded to protect his job by ordering and keeping on hand thousands of dollars' worth of material that would not in all probability be used inside of 5 to 10 years, and some of it probably never. As no one ever checked up his stock or ordered any of it shipped to other points, this comparatively small drain on the company's assets went on unchecked for years, although the purchasing agent was in no wise at fault, for he had bought on duly approved requisitions such quantities and kinds as were specified.

The foregoing is a review of conditions at only one comparatively small point on a not very large railway in which the mechanical department was principally interested and really responsible, although the transportation department was not blameless, but from this, one may visualize as to possible and some actual conditions on many large systems, which report having on hand from $5,000,000 to as much as $50,000,000 invested in material and supplies, for the entire transportation unit.

Responsibility

There are on our railways in round numbers about 1,904,000 officers and employees, classified from No. 1 to 148, the number under each ranging from 72 under class 121, to 218,772 under class 52. Under class 1 and 2, executives, general and division officers, there are 17,314. Of other officers, foremen and agents, there are 99,000, making the total of all those who have to do with ordering material and supplies about 116,000, and this is rather below the real figure as there are several thousand chief clerks, supervisors, sub-foremen, etc., who also have to do with making requisitions for, distributing when received, and either conserving or wasting material and supplies for about 1,904,000 officers and employees on our railways.

If any one doubts the potential influence of these 116,000 men either on (a) current expenditures, (b) conservation of property or funds entrusted to their care, and finally (c) to preserve the integrity of the company's capital account and thereby save millions of dollars to the carriers of this country, they are not well informed on the subject.

It is fair to assume that no specification, prescription, formulae or set of rules, can be laid down that would fit all or even a majority of cases. Manifestly, the eradication of customs, habits and practices so long followed and thoroughly entrenched in our railway organization will not yield without determined leadership of strong men, whose methods of procedure will of necessity be iconoclastic in character.

It is a most interesting, inviting and fertile field for the railway economist.

Cost of Locomotive Fuel

The average cost per ton of coal used as fuel for road locomotives in freight and passenger train service for Class I roads in July was $2.68, as compared with $2.98 in July last year, and for the seven months of 1925, including July, the average was $2.77 as compared with $3.15 last year, according to the monthly bulletin of fuel costs compiled by the Interstate Commerce Commission. This covers only fuel charged to operating expenses and does not include switching and terminal companies or fuel for switching locomotives. While the cost of coal shows a reduction the average cost of fuel oil per gallon increased, from 2.75 to 3.18 cents for the seven months period.

Mechanical Appliances for Lubricating Locomotives

Continuation of Reports to Traveling Engineers' Convention

There are varying conditions under which locomotives are operated, such as the difference existing in the locomotive with properly fitted pistons and rings and one which has nearly completed its mileage; also, the difference existing in lubricating the saturated and the superheated locomotives, as the superheated locomotive with a higher degree of heat breaks down the oil film so much more rapidly; again, the difference existing in operating an engine in good water territory as compared with the alkali waters of the West and Southwest; also, the locomotive of medium steam pressure as compared with locomotives of higher pressure. Again, we have locomotives operating in through service, which require different handling of lubrication features as compared with engines in local service.

These points are mentioned in order to draw attention to the difficulty in recommending a definite amount of oil to be used per mile. In arranging for the proper lubrication of an engine, the above mentioned different features must necessarily be taken into consideration. Before the advent of the superheated engines, the question of lubricating valves and cylinders did not present a very serious problem, but the introduction of the superheater with its high degree of superheated steam and fast and heavy service made it necessary to provide a means of furnishing a constant and uniform supply of oil to the valves and cylinders.

Until recently the hydrostatic lubricator of various designs had been the only medium used for applying oil, but with the advent of larger locomotives it has been felt that a device should be produced which would fulfill these functions more efficiently. With this end in view, the mechanical or force feed lubricators of various designs have been placed on the market, and have been applied to a considerable extent. The committee sent out a questionnaire to the membership with a view of securing information as to the degree of success secured from the application of the force feed lubricators; also, how their operation compares with the hydrostatic lubricators. The replies received would indicate that while a great number of those lubricators have been applied, they have not been in service long enough to secure definite data as to their efficiency as compared with the hydrostatic lubricators.

Each of the two types of lubricators has its separate merits and defects. For instance, by applying the hydrostatic lubricators to the large modern engines, it has been felt by some that due to the great length of the oil delivery pipes serious difficulties were being introduced in delivering the oil successfully to the valves and cylinders.

Also, in long passenger runs great difficulty has arisen through engineers covering the first divisions using the greater portion of the oil supply and, in many cases, leaving the man covering the last lap of the run short of oil. This feature would by the mechanical or force feed lubricator be taken out of the control of the engineer, thus insuring a continuous and constant supply of oil covering the entire trip. The amount to be supplied can be regulated to cover the requirements demanded by the class of service in which the engine is working.

Not being able to secure any definite data as regards to the comparison of the hydrostatic and mechanical lubricators, the chairman of this committee will give his personal observation. We have applied mechanical force feed lubricators to our mountain type locomotives operating in heavy fast passenger service and have secured very satisfactory results. Certain defects were encountered, but with the experience we have gained these are readily overcome. The chief defect was choke valves leaking, which allowed steam to back up in the oil pipes and condense in the oil chamber. This condensation settled to the bottom and in some cases was of such a volume as to float the oil above the intake of the pump. This defect can be easily detected and remedied by the simple practice of opening the drain valve at the bottom of the lubricator and if water appears, this is an indication that a leaky choke valve exists and requires attention. Our staff has now been instructed and trained to watch this feature. The result is that this defect has now been practically eliminated. There are also instances where the lubricator apparently did not feed on one side. The cause of this was found to be choke fittings corroded and seized.

I would like to call attention to a point which came under my personal observation. We had two 34% engines of the Pacific type in heavy local passenger service. One of the engines was apparently not getting sufficient oil in one side. A test showed that the lubricator was delivering the oil all right. Further examination disclosed that the piston rings on this side were worn, causing a blow, but it was not sufficient to be detected out of the stack. The rings were changed and no further trouble was experienced in regard to the lubricator. I wish to bring out this fact that the oil supplied by the mechanical lubricator had been adjusted to a nicety and was sufficient so long as the rings were tight, but as soon as the rings started to blow there was not then sufficient lubrication, and I became convinced that the properly adjusted mechanical lubricator would immediately show up the defect when the engine started to blow. I do not doubt but that had this engine been equipped with a hydrostatic lubricator the engineer would simply have adjusted the lubricator to get more oil to that side and the blow would have continued with the consequent loss of fuel until sufficient steam would be escaping to be detected through the stack.

Some authorities claim that a lubricator should feed an amount of oil corresponding to the speed of the locomotive. This is not good reasoning, because the volume of oil required for lubrication is not always in proportion to the velocity, or to the area rubbed over, and especially is this so when the temperature of the rubbing surfaces is increased by some other agent than friction, which greatly reduces the viscosity of the lubricant and destroys the oil film in a very short time.

On this account the volume of cylinder lubrication would be regulated more by the cylinder temperature than by the area rubbed over. Assuming, then, that on account of occasional high water or bad water the oil film on the cylinder walls has been destroyed, how is this lubricating film to be restored if the volume of lubricant cannot be immediately increased? I might say that this film can be restored with the mechanical lubricator by lengthening the cut-off, which most generally would come in line when a condition of this kind arises. With a hydrostatic lubricator it would be necessary for the locomotive engineer to readjust the lubricator feeds.

The cylinder walls on a 28 x 30 in. engine have an area of about 6,000 square inches and it would require approximately 150¼ drops of oil to restore the oil film on this area, which could not be accomplished with a device that was set to supply only the necessary amount of lubricant to meet perfect running conditions. On locomotives it is considered good practice to either start the lubricator at the ordinary rate of feed some minutes before the engine leaves the initial terminal, or feed fast for a short time after leaving. The reason for this practice is simply to establish an initial oil film that had been destroyed on account of the engine being idle at the terminal and this same condition takes place when the engine is delayed for any length of time on the line of road.

On heavy freight hauls the temperature of the cylinders becomes very high on account of the long cut-off, and although the surface rubbed over per minute may be low, the temperature of the oil film will be high, and it is the temperature that reduces the life of the oil film rather than the number of times it is rubbed over, and the amount of oil required will have a closer relation to temperature than to area rubbed over when the temperature is due to a foreign agent.

The oil film is also often destroyed by the admission of front end gases to the cylinders when they are at high temperatures, and it must again be built up by the admission of a little excess oil, because the regular feed only supplies the necessary amount to replace the regular wear of the film, and cannot be expected to build up a new film. The lubricator must be equipped so its capacity can readily and quickly be adjusted to meet requirements.

Force feed lubricators have their drive rod connected by two methods: to the Walschaert link, giving it a uniform movement, or to the valve cross-head, giving it a variable movement corresponding to the cut-off. In some cases it has been connected to the top of the Walschaert combination lever, but at short cut-off this point becomes almost a stationary fulcum point, so that very little movement is imparted to the lubricator lever. The method of connecting it to the valve cross-head is undoubtedly the best, because even at the shortest cut-off it always has the lap and lead movement, but this leads to abuses, as engineers will then run with longer cut-off so as to increase the oil feed.

Some disadvantages to be noticed with the hydrostatic lubricator are that on account of the height of modern cylinders and valves and the limited height of the cab it is difficult to get the necessary slope for the oil pipes, and because of congestion in the cab and limited height it is difficult to place the lubricator so that it can be operated and filled efficiently. The increased length of the oil pipes on modern power has also increased the frictional resistance of the steam flow and thereby decreased somewhat the volume flowing through them.

With respect to the question of separate oil feed to the cylinders, it is evident that such is an improvement in cylinder lubrication. It has been rendered necessary due to the increased length of the oil pipes to the valves greatly increasing the friction and diminishing the flow of steam through them and thereby making another set of pipes necessary.

Among the replies received to the questionnaire sent out was one from the London Midland and Scottish Railway Company, stating that this railway has 513 locomotives equipped with mechanical lubricators. They have no locomotives equipped with either the two-feed or the four-feed lubricators for oiling valves and cylinders, but a large number of their engines are fitted with eight-feed mechanical lubricators, and they also have three-cylinder compound passenger engines fitted with twelve-feed mechanical lubricators. In regard to the type used, they state that the mechanical lubricator used is of their own design, each oil supply being fed by its own pump unit. Regarding tests conducted between mechanical force feed and hydrostatic lubricators, they state that they have fitted some engines with hydrostatic lubricators, but prefer the mechanical lubricator.

To the sixth question, how they compare in efficiency and what were the comparative results in regard to consumption of oil, the reply is as follows: "From our experience, the mechanical lubricator has proved very efficient and lends itself to adjustment and a constant feed, which permits of the most economical working conditions. The adjustment of the oil feed is not under the control of the enginemen. The hydrostatic lubricator adjustment is under the control of the enginemen and, being very sensitive, it is difficult to obtain economical results."

In answer to the seventh question they state that "the condition of the working surfaces of the cylinders and packing rings with mechanical lubrication is quite satisfactory, no undue wear being noticeable." As to their experience in regard to maintenance, they reply that it is very rarely necessary to interfere with the mechanical lubricator between the shopping periods of a locomotive. Also, that they have no particular data of mileage per lubricator failure, as such failures are very rare.

The talk on lubrication of valves and cylinders so far has had to do with valve oil and of different methods of supplying it to valves and cylinders, but at least one large system has secured some very good results from the use of day graphite for lubricating valves and cylinders. This graphite is prepared in the form of solidified cakes and is fed by what is known as a pendulum graphite lubricator. The magazine containing the graphite is situated on top of the boiler and back of the smoke-stack. The natural side motion of the locomotive while running causes the pendulum to swing over the cakes of graphite and dusts or scrapes off a small amount of graphite at each swing. The graphite scraped off passes through a pipe into the superheater header and extends to the valves and cylinders.

				Used Pts. Valve Oil			Miles Per Pint Valve Oil			
Engine	Train	No. cars	Miles	Valves and Cylinders	Stoker Feed Water Air Pump	Car Oil	Valves and Cylinders	Stoker Feed Water Air Pump	Car Eng. Compl.	Mad. Kipp Lubricator at 35% Cut-off
6022	14	8	289	4	⅜	8½	72	771	34	2 nicks
6022	21	9	233	3⅝	..	6	65	...	39	3 nicks
6022	20	8	233	4¾	..	6	40	...	39	3 nicks
6022	17	9	289	7¼	..	5	40	...	57	3 nicks
6022	110-18	8	179	2 15/16	..	4	61	...	45	2 nicks
6022	9	10	179	2½	..	4	72	...	45	2 nicks
6033	112-16	8	289	3	..	6	96	...	48	2 nicks
6033	15	8	289	4	..	6	72	...	48	2 nicks
6022	110-18	12	179	3 15/16	..	4	46	...	48	2 nicks
6022	9-7	13	179	3¾	..	4	48	...	48	2 nicks

The hydrostatic lubricator in the cab was set to feed 1 drop per minute.

You will observe that this method of lubrication has the same constant effect as the mechanical lubricator, as it only feeds while the engine is in motion. It is the opinion of those who have had experience with this method of lubrication that the graphite passing through the superheat units has the effect of preventing leaks developing in same. It is noted that engines equipped with the graphite lubricator did not give as much trouble with leaky units as other engines operating over the same territory and lubricated by oil supplied direct to the valves and cylinders.

It also developed that engines lubricated by graphite would stand a shot or two of water without losing all their lubrication. While there are no figures to demonstrate it, nevertheless it is the opinion of those in touch with this means of lubrication that less wear was experienced on the cylinder and valve packing rings and valve and cylinder bushings. They also claim that the graphite would stand a greater degree of heat than oil without having its lubricating qualities affected.

While the dry method of lubricating valves and cylinders has not been brought into use to any considerable extent, it is nevertheless the opinion of the Committee that it offers certain advantages, and we would strongly recommend that this feature of lubrication of valves and cylinders be gone into as thoroughly as possible.

The report was made by a committee consisting of A. N. Boyd, road foreman of engines, Canadian National; W. E. O'Brien, Buffalo, Rochester & Pittsburgh; C. H. Holdredge, dist. road foreman of engines, Southern Pacific; J. W. Wells, road foreman of engines, New York, Chicago & St. Louis, and G. C. Jones, div. road foreman of engines, Atlantic Coast Line.

Progress Made in Mechanical Stokers and Effect on Cost of Maintenance and Operation

The commercial application of mechanical types of stokers to locomotives began in the year 1910. However, committees of the Railway Master Mechanics' Association have been reporting on the development of stokers since 1904.

In May, 1909, a locomotive on the Lake Shore & Michigan Southern Railroad was equipped with the first experimental stoker of the Street design. In 1910 five more of these stokers were put in service, three of which were placed on the Lake Shore & Michigan Southern, where the first stoker-equipped locomotive was being operated. In 1911 seven more locomotives on four different railroads were equipped. All of the last seven, with but one exception, were provided with coal crushers on the tanks and handled run-of-mine coal. All machines were in service at the time of the committee's report in the year of 1915.

In 1911 the Chicago, Burlington & Quincy designed a M-2 Santa Fe type of locomotive with tractive effort of 72,800 pounds, weight on drivers 301,000 pounds and grate area of 88 square feet, calling for fuel consumption required to develop maximum tractive effort which was considered beyond the possibilities of hand-firing methods. Five of these locomotives were built in 1911, and were equipped with the Barnum underfeed type of stoker. This type of stoker was removed, due to apparent inadequate capacity for requirements, also because of trouble experienced with design of mechanism of conveyor. Trouble was also caused by the filling up of the fire-box due to high ash contents of coal fired, with resultant delays in cleaning of fires. Mention is made, however, that with this type of stoker no trouble was experienced in the distribution of fuel over the grate area as a whole.

Records available are not clear as to the exact condition responsible for removal of the stokers. The above locomotives were later assigned to districts where they could be hand fired, which, however, was not successful until experiments had determined that the grate area would necessarily have to be reduced approximately 25% by blocking the grate area in the fire-box with fire-brick. This particular type of locomotive was later equipped with a mechanical stoker which enabled the engine to be operated successfully to its maximum capacity.

In 1912 there were placed in service 165 machines of the screw conveyor type, being applied on four different railroads. In January, 1913, seven more were placed in service with orders for fifty more, and an additional order of 170. We find there have been 189 Street stokers applied to locomotives in service, with 173 on others.

Up to 1913 approximately 446 stokers were applied or under order for installation to locomotives. It is interesting to note that of the twelve types of different designs of stokers originally up to 1913 but two distinct types of the above stokers were reported by the committee of the Railway Master Mechanics' Association as being capable of successfully firing locomotives, so far as the approval of the above committee was concerned. These two were the Crawford stoker of the under-feed type and the Street stoker with the scatter feed. Others were mentioned at that time as undergoing experimental tests.

The 1913 period seemed to have resulted in eliminating many stoker designs, reducing their number, namely to the more prominent Crawford and Street types of stokers. However, the twenty other stokers undergoing development brought the Gee and Hanna out as stokers in which favorable improvements were looked for. Up to April 1, 1915, 1,006 stokers had been applied to locomotives, representing five different manufacturers, four bringing out the over-feed type and one the under-feed stoker. In the intervening years, both from a theoretical and practical standpoint, the mechanical stoker has developed to a state of perfection in advance of the commercial stage, it being gratifying to note that the changes in these designs of stokers since the year of 1917 have through reinforcement in parts as a whole developed a strong and rugged type of machine, with resultant elimination of stoker failures and decreased cost of maintenance.

Up to June 1, 1924, 8,989 mechanical stokers had been applied to locomotives.

Improvements in the design of modern locomotives with heavier capacity are not withheld pending decision as to whether or not human physical effort can supply the necessary pounds of fuel to be consumed per square foot of grate area per hour in advance of maximum of 5,000 pounds to that necessary for consumption to develop maximum tractive effort of a locomotive, more especially through sustained periods of operation where speed is desired, with a resultant constant maximum piston thrust and uniform tractive effort being maintained as desired.

From information obtainable and from personal observation it should be possible for a mechanical stoker of the present-day type to operate approximately 90,000 miles on the locomotive before receiving a general overhauling; however, at the time the locomotive is receiving classified repairs the stoker should receive a thorough inspection and the necessary light repairs be made. It is presumed with reference to the above that the stoker and parts received proper lubrication and correct operation.

From information available, at sources where inquiries were made, as to actual differential covering cost and maintenance of past types of stokers over that of the present-day type, no figures were to be had; however, the standard type of stoker in operation today can be maintained at approximately from one-tenth of one cent to one and one-half mills per locomotive mile. This includes the cost of all stoker parts used at overhauling; however, minus cost of labor.

In the past many charts have been submitted to the various railroad associations, furnishing data of tests made as between hand and mechanical fired locomotives, bearing out the fact that with the application of the mechanical stoker a degree of economy can be effected from various angles, chiefly in decreased transportation and fuel cost, as well as reducing the time element in moving of trains between terminals.

There is no question but what the modern stoker-fired locomotives of today are serving their purpose thoroughly in the prompt and economical movement of heavy tonnage trains over that of the train tonnage hauled prior to stoker development. It is essential that the degree of economy affected through the assignment of stoker-equipped locomotives, usually with higher capacity of tractive effort to territory on which hand-fired locomotives were formerly operated, and with main and yard track facilities unsuitable for the economical operation and movement of longer and heavier tonnage trains handled by stoker-fired locomotives, should be given due consideration, especially when placed on a comparative fuel basis with a lighter hand fired locomotive.

Attention is called to the committee report at the convention of the Traveling Engineers' Association in 1920 on the subject: "Operation and Maintenance of Locomotive Mechanical Stokers in the Viewpoint of Efficiency and Economy," by I. P. Burney as chairman of the committee. Your present committee feels that the report referred to covered so well the practice in effect at present governing the economy of maintenance and operation, as being a dependable factor in low cost of maintenance and operation, that little can be added to it. It was thought, however, that with the present-day roundhouse standard of organization coupled with the effort of the stoker companies to assist such forces in proper maintenance methods, that this has brought about a further degree of efficiency with a resultant and desirable low cost of maintenance.

Due consideration should be given to the construction of locomotive tenders to provide fuel supply for the use of the fireman who either through lack of knowledge in the operation of the stoker or by a clog occurring may be required to revert to hand firing. As a rule in case of stoker trouble a fireman will make added efforts to hand fire the locomotive if fuel is available without restriction. This will also increase the tendency of firemen to give proper consideration to the use of the scoop during standby and other delays, at which time the temperature of the fire-bed may become low, and if without forethought extreme care is not taken banks may form over the fire-bed through the use of the stoker.

On territory where the application of mechanical stokers is being considered it is important to establish the practice of removing all foreign and non-combustible material at fuel stations and coal mines. Delays will be eliminated by the establishing of this practice and continuity of operation assured to stokers, thus preventing interruption of service at critical periods of operation during sustained maximum efforts on the part of the locomotive engine.

The inclination of individuals to study and qualify for promotion has through the application of the stoker shown itself on the increase. The present progressive examination is of such a nature that earnest study must be applied for an individual to qualify from the position of fireman to that of a locomotive engineer.

Education, with supervision properly exercised, is the keynote for success of engine crews. In handling modern locomotives with their increased capacity and appurtenances, the mind of the individual must be trained to comply with the recommended practice, in order that the certain physical action necessary will be the expected performance, instead of practices formed through habits, based mainly upon past physical efforts.

Supervision of the above nature will attain a larger degree of efficiency in general. One of the most desirable economies effected is that the reduction of physical effort to psychic action on the part of engine crews to properly operate mechanical devices will conserve future enginemen's years of activity in service to their respective railroads. In the successful operation of mechanical stokers particular stress has been given to the fact that stokers are not automatic and that human intelligence must be the guide for their successful and economical operation.

Even distribution of steam with air reverse gears, positive in being able to control such, are essential factors in expected performance of stoker or hand-fired locomotives.

Valve and cylinder packing blows should be observed with extreme care. Engine crews should be instructed in the art of testing for same. As the mechanical stoker can and will deliver the required fuel before the weakening of the locomotive due to loss of power is discernible, certain engine crews are not entirely familiar with the proper method of discerning and testing, especially so in the case of superheated locomotives.

Special attention should be given to replacement of stoker parts, as well as maintaining the openings in the firing nozzles, distributing arrangement and true alignment of such parts by the roundhouse forces.

Operation of stokers on inbound or terminal tracks, prior to the arrival or after leaving of crews, except by inspectors, should not be permissible.

It is important to the point of insistance that fire-beds are built up at terminal points and delivered to the crews in a light and level condition and free from clinkers.

Prior to leaving the outbound track the whole stoker should receive close observation of the engine crew, in order to know that the same is in serviceable condition and that the flow of fuel is available. Firebeds should be built up by hand-firing and a proper degree of heat obtained. The thickness of the fire-bed is to be in proportion to the degree the locomotive will be worked and according to characteristics of the fuel used. Engineers should gradually work their locomotives up to the maximum working capacity needed, rather than in a sudden manner allowing the firemen to bring the fire up to the proper degree of heat, depth and division of fuel over the grate area as a whole, so that forcing of the fire may not be required. This will insure getting the fire-bed at what we term a light, bright and level condition, which is necessary for securing the most economical results in consuming the volatile gases of the fuel with resultant barometer of efficiency at the stack—a clean one.

Railroad companies, under present legislative requirements governing the sale of their business product and with only a comparatively small per cent of control over their earnings, necessarily are required to deliver their product regardless of revenue earned in a prompt, safe and at the same time an economical manner.

Realizing that the sale of transportation offered by railroads is of a highly competitive nature, the movement of freight traffic, especially manifest business, which includes practically all commodities offered, must be facilitated. This necessitates a varied reduction in the percentage between a minimum and maximum tonnage rating handled, so that the required schedules may be maintained and service delivered. This requirement, due to above causes, brings about a resultant increase in transportation cost, as well as increased number of pounds of fuel consumed per thousand ton gross miles. Because of this fact we are unable to give the locomotive the tonnage rating with which it could make an economical fuel performance with reduced transportation cost.

The schedule of the time table makers and tentatively expected performance of the extra as well as the regular trains by the dispatcher is based upon the even, steady and continuously normal performance of the locomotive. By no other presumption can the plans of the dispatcher become definite. Dispatchers must have certain confidence in locomotives as well as in engine crews to perform certain tasks. These tasks, regardless of weather conditions, the modern locomotives will do, even though called upon to develop in comparatively short time rates of horsepower from zero to a total maximum effort. With the mechanical stoker, dispatchers feel assured that they have a locomotive with which there is no doubt of failure resulting from the physical effort on the part of the fireman in being unable to maintain constant pressure under sustained effort.

In conclusion, the fact is realized that there are many points that enter into the application of as well as the efficient and economical operation of mechanical stokers, with resultant low cost of maintenance and operation. Some of these points have been ably covered and discussed at former conventions of the Traveling Engineers' Association.

Your present committee has endeavored to outline prevalent ideas, which it is hoped will foster discussion to the extent of bringing about recommended practices, insuring more efficient result in the operation of the modern mechanical-fired locomotives of today.

The report was made by a Committee consisting of D. I. Bergin, road foreman of engines, Wabash; J. P. Britton, road foreman of engines, Baltimore & Ohio; J. H. De Salis, master mechanic, New York Central; M. A. Daly, fuel supervisor, Northern Pacific and Henry H. Wilson, general road foreman of engines, Baltimore & Ohio.

Snap Shots — By the Wanderer

I do not know whether I am right or not, but it seems to me that there are indications that railroad men show signs of getting away from the finicky notion that they can not publicly recommend an article that is patented or of exclusive manufacture. It was a curious attitude, when existing conditions were taken into consideration. There was a time when it was quite common to distribute stock of a company, that had a commodity to sell the railroads, among those officials who were in a position to have a favorable influence upon the sales. The recipients of such stock gratuities were expected to and did speak very openly regarding the merits of those commodities to their own official colleagues, and were an important factor in their introduction on their own particular roads. But, if there was a public meeting in which those commodities might be endorsed to the benefit of the manufacturer, they were as dumb as oysters and opposed any suggestion that their association should recommend a patented device.

There are some that have come into general use, since the patent expired, that could not get a recognition during their lifetime. Take for example, the Christie brake head. It is doubtful whether the majority of railroad men today ever heard of the Christie brake head, and yet it is the standard of all American cars, having lost its original name when it became the M. C. B. standard.

Now comparatively few of those heads were in use before the expiration of the patent. It received no endorsement from the association during its life, but just before it expired and the adoption of a standard head was up for consideration, one of the most prominent members of the Master Car Builders' Association, in discussing it, said, in substance: "It is the best and most feasible method of attaching the shoe to the head, and as soon as the patent expires, which will be in a few weeks, it ought to be adopted as a standard by the association."

Another patent that met with a similar fate was that of the Forney locomotive. No one would recommend it, and few would use it during the life of the patent, but no sooner had it run its prescribed life of seventeen years than Forney engines became very common, the elevated railroads of New York City using them by the hundreds.

In other words, it is or was bad form to endorse publicly a device that is protected by a patent because, as has been stated on the floor of more than one convention, it would accrue to the profit of some individual. Yet, when a device has forced its way upon the roads by its own intrinsic merits, it is accepted and discussed as a matter of course; and then there is apt to occur this strange paradox that the railroad men seem to resent any effort to replace it by its equivalent of something better. It would not be difficult to pick out more than one instance of this kind. So much are we the creatures of habit, that we forget and accept as a matter of course that which we have had forced upon us, and change our attitude of fear lest we should say a good word for the man who is struggling for a recognition. We recognize it when it is too late to be of benefit to him.

A few years ago one of the art associations conferred an honor upon an old man whose life work was nearly completed and who had forced his way to the front in spite of the opposition of this same society. He accepted the honor, but in his speech of acceptance he reminded the members that such an honor came too late to be of any material service to him and that if it had been conferred twenty years before, when he was doing his best work, it would have been of a great advantage to him. Whether we approve the courtesy of such a plain talk or not, the fact remains that it is a fact.

However, as I stated at the start, it seems to me that there is a tendency to ignore the old traditions in his respect and to at least tell the facts in regard to a device, even though there may be a reluctance to adopt it. This appeared first in some of the minor associations, where the members had no traditions of silence to uphold, and like other leavens, there is a hope that it may leaven the whole loaf.

A few months ago I recorded with some regret that the sanctity of the railway passenger car had been invaded by the street car advertising card, and in that particular instance had displaced the more or less commodious parcel rack with which the car had previously been equipped.

Evidently the infection is taking and we may look for its growth to an almost if not universal application in the not distant future. For, within the past few days, I have seen another application on a different road where there was a disinclination to remove the parcel racks. In this instance the cards were placed on the underside of the long rack that I have called the New Haven rack because it was first introduced on that road.

So there we are, I do not think that any one will maintain that the cards are an improvement to the appearance of the car, but as they probably improve the revenue of the road, we will have to forego our esthetic tastes in deference to the utilitarian age in which we are living, or perhaps it would be better to say, "spinning along."

It is, of course, the part of an old fogy to decry innovations and improvements, especially when there is a revenue connected with the same. But there are some things that indicate a cheapening of surroundings regardless of what they may really be worth in dollars and cents. For example, a cheap, or low grade restaurant have its walls placarded with all sorts of advertisements of the prepared food that it serves, lauding the A. B. C. hams and the X. Y. Z. frankfurters. One never sees anything of the sort in a restaurant of the better class. So while the display of advertisements in passenger cars will probably not decrease the volume of travel or the class of travel it will undoubtedly give a road the reputation of being of an inferior grade, whether it is or not. At least until our eyes have become accustomed to the innovation and we accept it as a matter of course, as we are sure to do in time.

Several railroads of the country are making more or less systematic efforts to train men for various positions of responsibility and are giving considerable publicity to the fact.

While they are about it, why would it not be a good idea to train some men for the position of train announcers? For usually the articulation of the men occupying these positions is worse than that of the average singer, and that is bad enough, Heaven knows. There is no reasonable excuse for either speaking or singing so that no one who hears can understand what is uttered. Anyone, without an actual impediment can be taught to speak distinctly, but the average man is careless, with the result that, when he attempts to make a public announcement, he mouths his words worse than usual and becomes quite unintelligible. Then matters are made worse by putting such a man at the speaking end of a telephonic megaphone, when a mere gibberish roar is what the public hears. This is particularly exasperating because the speaker is inaccessible and cannot be asked what he has been saying.

When the ordinary announcer has shouted: "Tra nar red f'r Br-sh-ky, Pro-ha emma puh, tra ten." You go to him and ask if he has been talking about Peoria and find out. But when one stands on a platform where trains are passing at a few second intervals, and when there is no one available from whom questions can be asked; things are apt to be confusing when reliance must be placed on a telephonic megaphone, and the wonder is that, in such places, more people do not board the wrong train than they do.

Annual Meeting of the A. S. M. E.

The Pennsylvania Railroad was host on October 5th, 6th and 7th to the American Society of Mechanical Engineers, which held its regional meeting at Altoona, Pa. It has been forty-two years since the Society met in Altoona. Its membership now includes 18,000 engineers organized into 67 local sections throughout the country. Many of the most distinguished engineers attended the Altoona sessions.

In addition to important technical discussions and addresses of general interest, one of the features of the meeting was an operating demonstration of a large electric locomotive at the Pennsylvania Railroad's test plant in the Altoona Shops, the largest railroad shops in the world. This locomotive is the first of its kind to be so tested. The visiting engineers thus had an opportunity to observe the methods of measuring and operating characteristics of one of the newest of railroad engines. The test plant at Altoona has been one of the important factors in the development of steam and electric locomotives on the Pennsylvania Railroad System.

The formal program of the meeting opened on Monday, October 5th, at the Penn-Alto Hotel. The members of the Society and their guests were welcomed by Elisha Lee, Vice President in Charge of Operation of the Pennsylvania Railroad. At this meeting, too, honorary membership in the American Society of Mechanical Engineers was conferred on General William Wallace Atterbury, President of the Pennsylvania Railroad. General Atterbury was presented to the Society by Charles Day, of Day & Zimmerman, Philadelphia, and the certificate of honorary membership was bestowed by William F. Durand, President of the Society.

The session on Tuesday was opened by an address by Samuel Rea, Retired President of the Pennsylvania, who discussed transportation in its physical, economic, financial and legislative phases and gave his views on the future of railroad transportation in this country. A paper on the Locomotive Testing Plant and its Influence on Steam Locomotive Design was read by Lawford H. Fry, which dealt with the history of locomotive testing plants and the progress in locomotive design which they have made possible. Mr. Fry's paper will be published in an early issue of Railway and Locomotive Engineering.

Samuel P. Bush, President of the Buckeye Steel Castings Company, addressed the meeting on Tuesday on The Transportation Industry and The Engineer. On Wednesday, there were addresses by Albert J. County, Vice-President in Charge of Treasury, Accounting and Corporate Work of the Pennsylvania Railroad, and by Dr. M. E. McDonnell, the Railroad's Chief Chemist, who presented a paper on Rust-Proofing of Metals.

The petition to the counsel of the Society nominating General Atterbury for honorary membership says of his qualifications for this honor:

"Upon no other agency in modern life is American industry and the prosperity of the nation more dependent than upon railroad transportation. General Atterbury is one of the recognized leaders in that field. The high service he has rendered, both in the field of mechanical engineering and in the field of railroad management, constitutes a basis for 'acknowledged professional eminence' as required by our Constitution."

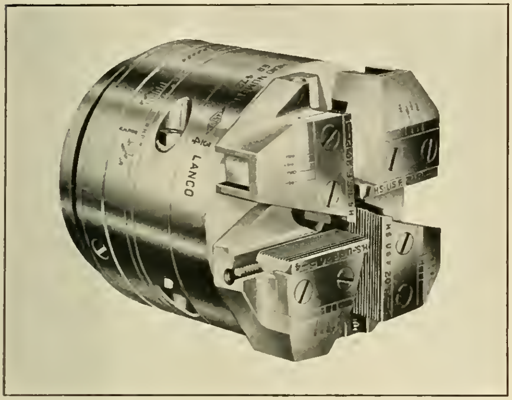
The program for the meeting included social activities, and inspection of the Altoona Shops, a trip by special train to the site of the inclined planes of the Old Portage Railway, the original means of transportation over the Alleghany Mountains, now crossed on the famous Horseshoe Curve of the Pennsylvania Railroad.

New Lanco Die Head

The Landis Machine Company, Waynesboro, Pa., has placed upon the market a new series of Landis thread cutting die heads. This new head is known as the Lanco head.

The Lanco head has the chasers supported on the front face of the head. This permits of easy access to the chasers when it is necessary to remove them for grinding and when changing from one pitch to another.

This new head is made entirely of high carbon steel



New Lanco Die Head

and it is heat treated throughout, and ground. This construction together with the compact design of the head reduces the wear to a minimum and prolongs the life.

The head is adjusted to size by means of an adjusting worm. The adjusting worm is under the proper turning tension at all times, thereby eliminating the necessity of locking it for each adjustment of the die head for size. The graduated dial at the end of the adjusting worm gives a variation in adjustment of approximately .005" for each graduation. The head, when threading, is locked within itself by the engagement of two closing pins in hardened bushings. It is opened and closed automatically.

The head is graduated for all sizes of bolts, both right and left hand, and right hand pipe within its range. All passages and openings into the interior of the head are entirely covered under service conditions, making it impossible for dirt and chips to enter.

The Lanco head is made in the 3/8", 9/16", 3/4", 1" and 1½" sizes. It is applicable to all makes of automatic, semi-automatic and hand operated threading machines.

The Lanco head employs the Landis long life chaser.

Notes on Domestic Railroads

Locomotives

The Chesapeake & Ohio Railway has ordered 20 heavy Mallet type locomotives from the Baldwin Locomotive Works, to cost approximately $2,250,000.

The Chicago South Shore & South Bend Railway has ordered 4 electric freight locomotives from the Westinghouse Electric & Manufacturing Company, to cost approximately $225,000.

The Tennessee Copper Company has ordered one six-wheel switching locomotive from the Baldwin Locomotive Works.

The Atlanta & West Point Railway is inquiring for 4 Mikado type locomotives.

The Tennessee Central Railroad is inquiring for 4 Mountain type locomotives.

The Denver & Rio Grande Western Railroad contemplates buying 10 heavy locomotives.

The Central Railroad of New Jersey has purchased the first oil-electric locomotive to be purchased by a railroad in the United States, from the Ingersoll-Rand Company, the Central Electric Company, and the American Locomotive Company.

The Chesapeake & Ohio Railway has placed a contract with the American Locomotive Company covering the building of 50 heavy Mikado locomotives at a cost of approximately $3,500,000. According to the contract the locomotives are to be built at the Richmond, Va. plant of the American Locomotive Company and delivery will begin early in December.

The New York, New Haven & Hartford Railroad is reported to be inquiring for 10 Mountain type locomotives.

The H. L. Bruce Company has ordered one Prairie type locomotive from the American Locomotive Company.

The Louisville & Nashville Railway is inquiring for 8 Mountain type and 24 Mikado type locomotives.

The Louisville & Nashville Railroad has placed orders with the American Locomotive Company for 24 heavy Mikado type locomotives, 165 tons, and will have 27 in. by 32 in. cylinders, which are to be built at the Brooks plant of the American Locomotive Company, located at Dunkirk, N. Y.

The Seaboard Air Line Railway has placed orders for 6 Mountain type locomotives and 4 Mikados with the Baldwin Locomotive Works.

The Pintados Iquique Railway, Santiago, Chile, plans to purchase 23 locomotives within the next few months including Santa Fe, Mikado, Garrett and Mallet types.

The Sorocabana Railway of Brazil has ordered 11 locomotives from the Baldwin Locomotive Works.

The Richmond Car Works has ordered one six-wheel switching type locomotive from the American Locomotive Company.

The Chesapeake & Ohio Railway is inquiring for 110 locomotives as follows: 20 simple Mallets, 75 heavy Mikados, 5 heavy Pacifics, 10 heavy switchers.

The Chicago, Lake Shore & South Bend Railroad is inquiring for 3 electric locomotives.

Freight Cars

The Armour & Company, Chicago, Ill., has ordered 300 steel underframes for refrigerator cars from The Bettendorf Company.

The Equitable Equipment Company, New Orleans, is inquiring for 50 flat cars for export.

The Baltimore & Ohio Railroad has placed orders for 1,000 all steel box cars with the Bethlehem Steel Company, and also for 500 with the Standard Steel Car Company.

The Chesapeake & Ohio Railway has ordered 100 steel underframes for caboose cars from the Standard Tank Car Company to cost approximately $250,000.

The Palace Poultry Company, Chicago, Ill., has placed an order for 150 poultry cars with the Illinois Car & Mfg. Company.

The Illinois Central Railroad has ordered 500 single sheathed box automobile cars from the American Car & Foundry Company and 500 from the Pullman Car & Manufacturing Company.

The St. Louis-San Francisco Railway is inquiring for 3,000 50-ton single sheathed box cars.

The Louisville & Nashville Railroad has ordered 500 box cars from the Standard Tank Car Company; 500 coal cars from the Pressed Steel Car Company and 250 flat cars from the Bethlehem Steel Company, to cost approximately $2,500,000.

The Montour Railroad is inquiring for 500 gondola cars.

The Nainesport Mining Transportation Company has placed orders for 6, 50-ton hopper cars with the American Car & Foundry Company.

The Armour & Company of Chicago, Ill., are inquiring for 300 steel underframes for freight cars.

The Fruit Growers Association is inquiring for 300 underframes for refrigerator cars.

The Illinois Central Railroad is inquiring for 800 box cars, 200 automobile cars, 200 stock cars and 100 flat cars.

The Baltimore & Ohio Railroad is inquiring for 100 box car bodies.

The E. I. DuPont de Nemours Company has placed an order for 22 anhydrous ammonia tank cars with the Central American Tank Car Company.

The Chicago & Northwestern Railway has ordered 25 caboose car underframes from the Illinois Car & Mfg. Company.

The Southern Railway has placed an order for 10 horse cars with the Bethlehem Steel Company.

The Illinois Traction Company has placed an order for 50 hopper cars with the Mt. Vernon Car & Mfg. Company.

The Pennsylvania Coal Company has placed an order for 15 mine car bodies with the American Car & Foundry Company.

The New York Central Railroad has placed the following orders: 500 hopper cars with the Pressed Steel Car Company, and 500 with the Standard Steel Car Company, and 1,000 refrigerator cars with the Merchants Despatch Transportation Company.

The Georgia, Florida & Alabama Railway is reported to be inquiring for 250 box cars.

The Buffalo, Rochester & Pittsburgh Railway has ordered repairs to 200 hopper cars from the Bethlehem Steel Company.

The General Fuel Corporation has placed an order for 50 mine cars with the American Car & Foundry Company.

The Georgia Pine Turpentine Company, New York City, has ordered one tank car from the General American Car Company.

The Cambria & Indiana Railroad has placed an order for repairs to 200 hopper cars with the Bethlehem Steel Company.

The Pine Hill Coal Company has placed an order for 50 mine cars with the Pressed Steel Car Company.

The Mathieson Alkali Company is inquiring for 68 quarry cars.

The Spokane International Railway is inquiring for 3 refrigerator cars.

The Haynesworth Mining & Transportation Company has ordered 6 steel hopper cars of 50 tons capacity from the American Car & Foundry Company.

The Palace Poultry Car Company, Chicago, Ill., is inquiring for 200 poultry cars.

The Kansas City, Mexico & Orient Railway has placed an order for 50 hopper cars with the Mt. Vernon Car & Manufacturing Company.

The Baltimore & Ohio Railroad has placed orders for 1,000 hopper cars with the Standard Steel Car Company.

The Fruit Growers Express has ordered 387 steel underframes from the Pressed Steel Car Company.

The Gulf, Florida & Alabama Railroad has placed an order for 250 box cars with the General American Car Company.

The Chicago, Burlington & Quincy Railroad is inquiring for 500 center sills for freight cars.

The Babcock & Wilcox Company has ordered one 50-ton gondola car from the American Car & Foundry Company.

The Great Northern Railway has ordered 500 50-ton general service cars from the Bethlehem Steel Company.

Passenger Cars

The Louisville & Nashville Railroad has ordered 4 steel coaches, 8 middle smoking room coaches, 4 end smoking room coaches, 2 combination passenger and baggage car, 2 postal cars, 4 baggage horse cars and 2 dining car shells from the American Car & Foundry Company, also 10 baggage cars and 4 combination baggage and mail cars from the Pressed Steel Car Company.

The New York, New Haven & Hartford Railroad has placed orders for 35 multiple-unit passenger cars with the Osgood-Bradley Company.

The Chesapeake & Ohio Railway has ordered 10 combination passenger and baggage cars from the Bethlehem Shipbuilding Company.

The Southern Railway has ordered 10 express cars from the Bethlehem Shipbuilding Corporation.

The Louisville & Nashville Railway is inquiring for 38 miscellaneous passenger cars and 2 steel dining car shells.

The Georgia, Florida & Alabama Railway has placed orders covering 2 combination baggage-express cars, 3 mail-express cars and 3 coaches with the Bethlehem Shipbuilding Company.

The Southern Railway has placed an order for 4 all steel diners with the Pullman Car & Mfg. Corporation.

The New York, New Haven & Hartford Railroad is negotiating for the purchase of 5 gas-electric cars and 20 steel underframes for baggage and express cars.

The Delaware & Northern Railroad has placed an order for one combination passenger-baggage-mail gasoline car with the J. G. Brill Company, Philadelphia, Pa.

The Chesapeake & Ohio Railway is inquiring for 10 steel passenger cars and 3 all steel mail cars.

The Key System Transit Company, Oakland, Calif., is inquiring for 40 multiple unit passenger cars.

The Chicago, South Shore & South Bend Railway is inquiring for 10 combination smoking passenger and baggage cars and 15 combination smoking and passenger cars.

The Great Northern Railway is inquiring for one passenger car underframe.

The Illinois Central Railroad is inquiring for 4 gasoline motor coaches.

The Louisville & Nashville Railroad is inquiring for the following passenger cars: 4, 61 ft. coaches; 4, 61 ft. vestibule partitioned coaches; 2, 70 ft. passenger-baggage cars; 4, 70-ft. smoking cars; 10, 70-ft. baggage-mail cars, with 15-ft. mail compartment; 2, 70-ft. baggage-mail cars, with 30-ft. compartment; 2, 60-ft. mail cars; 2 dining car shells and 4, 70-ft. coaches with middle smoking room.

The Louisville & Nashville Railway has ordered 3 combination passenger and baggage gasoline rail motor cars and one straight passenger gasoline rail motor car from the J. G. Brill Company, Philadelphia, Pa.

The Delaware, Lackawanna & Western Railroad has ordered 15 wide vestibule standard coaches from the Pullman Car & Mfg Company.

Building & Structures

The New York, New Haven & Hartford Railroad plans the construction of a bus terminal at Danbury, Conn., including a machine and repair shop, an office building for the New England Transportation Company, a subsidiary.

The Missouri Pacific Railroad has awarded a contract for the construction of a seven-stall roundhouse at Arkansas City, Kan., to cost approximately $32,500.

The Chicago, St. Paul, Minneapolis & Omaha Railway is reported to have placed a contract for the construction of a roundhouse and machine shop at Spooner, Wisc., to cost approximately $50,000.

The Chicago, Burlington & Quincy Railroad has awarded a contract covering the construction of a four-stall roundhouse at Hannibal, Mo., to cost approximately $25,000.

The Kentucky & Indiana Terminal Railroad contemplates the construction of a shop building, a storehouse and an office building at Louisville, Ky., to cost approximately $75,000.

The Virginian Railway has awarded a contract for the construction of a fire-proof sand handling plant for sanding their electric locomotives at Mullens, West Va.

The Canadian National Railways is building an addition to the shops at Limoilou, Que., to cost approximately $500,000.

The Atlanta, Birmingham & Atlantic Railway is reported to be planning improvements to its shops at Manchester, Ga.

The New York Central Railroad has awarded a contract for the construction of a machine shop, 60 ft. by 80 ft. at Airline Junction, near Toledo, Ohio.

The Southern Pacific Company are preparing plans for the construction of a terminal at Klamath, Oregon.

The Wabash Railway contemplates the construction of a one-story machine shop, 60 ft. by 120 ft. at Decatur, Ill.

The Pennsylvania Railroad is inquiring for bids on a group of shop buildings which will be located at 50th and Merion Streets, Philadelphia, Pa., to cost approximately $75,000.

The Texas & Pacific Railway has placed a contract covering new terminal buildings at Shreveport, La., which will include an eight-stall roundhouse, car repair shed, machine and blacksmith shops, power house, yard office and numerous other buildings, to cost approximately $925,000.

The Southern Railway is reported to be planning new locomotive car repair shops at Chattanooga, Tenn., to cost approximately $750,000.

The St. Louis-San Francisco Railway will improve and enlarge its passenger facilities and yards at Springfield, Mo., at a cost of approximately $300,000.

The Jefferson & Northwestern Railway is rebuilding the portions of its machine shops and locomotive repair shop which was recently destroyed by fire at Jefferson, Texas.

The Reading Company plans the construction of a new power house at Birdsboro, Pa.

The Norfolk & Western Railway plans the construction of a water softening plant at Richlands, West Va.

The Temiskaming & Northern Ontario Railroad has placed a contract covering the construction of a power house at North Bay, Ont., Canada.

The Clinchfield Railroad plans shop improvements including a ten-stall roundhouse, a new coaling station and additions to the machine shop and paint shop at Erwin, Tenn.

The Chesapeake & Ohio Railway has awarded a contract for the erection of a new boiler shop at Huntington, West Va. The building with equipment is estimated to cost approximately $575,000.

The Pennsylvania Railroad has installed a 100 ft. turntable at 55th street, Chicago, Ill., instead of 85 ft. turntable as reported.

The Illinois Central Railroad has closed bids for the construction of the superstructures of the buildings in the locomotive and car repair terminal which are located at Paducah, Ky. The buildings to be constructed include a locomotive erecting shop, locomotive repair shop, car repair shop, carpenter shop, wood mill and store room, foundry, boiler shop, blacksmith shop, power house, tank shop, and air brake shop.

The Minneapolis, St. Paul & Sault Ste. Marie Railroad has placed a contract covering a brick station at Cass Lake, Minn.

Items of Personal Interest

William Wallace Atterbury was elected President of the Pennsylvania Railroad on September 30. Mr. Atterbury succeeds Samuel Rea who retired on the same day under the pension regulations of the railroad.

Mr. Atterbury was born at New Albany, Indiana, January 31, 1866.

After receiving a liberal preparatory education, Mr. Atterbury was graduated from Yale University in 1886 with the degree of Bachelor of Philosophy. He entered the service of The Pennsylvania Railroad on October 11, 1886, as an apprentice in the Altoona shops. He received many promotions, and in 1903 he was made general manager of the lines east of Pittsburgh, becoming a vice-president six years later.

On May 17, 1916, Mr. Atterbury was elected President of the American Railway Association. As the head of this Association, he rendered invaluable service to the United States Government in connection with the transportation of troops and war supplies to the Mexican Border, as well as to the Atlantic Seaboard.

Shortly after the United States entered the war against Germany, Mr. Atterbury was requested by the Secretary of War to go to France and assume charge, as Director General of Transportation of the American Expeditionary Forces, of the details of organization for the construction and operation of the United States transportation requirements in France, as well as the harmonizing of them with those of our Allies in France. He held the rank of brigadier general.

Upon the termination of Federal control of the railroads, and the restoration of the railroad properties to their owners on March 1, 1920, General Atterbury resumed his active duties as Vice-President in Charge of Operation of the entire Pennsylvania Railroad System. He continued in this capacity until November 15, 1924, when he was appointed Vice-President of the Company, without designation, in order that he might act in a more general executive capacity, aiding the President in his administrative duties and acting for the President in his absence.

F. R. Butts has been appointed acting master mechanic of the Brookfield division of the Chicago, Burlington & Quincy Railroad with headquarters at Brookfield, Mo., to succeed **H. H. Urbach**, who has been assigned to other duties.

P. C. Morales has been appointed superintendent of machinery and motive power of the National Railways of Mexico, succeeding **S. A. Alzati**, resigned.

E. W. Beatty, president of the Canadian Pacific Railway has been chosen chairman of the Canadian Steamships, Ltd., succeeding **G. M. Bosworth**, deceased.

E. J. Cole, superintendent of shops of the Union Pacific Railroad with headquarters at Cheyenne, Wyo., has been transferred to Omaha, Nebr., succeeding **J. W. Highleyman**, acting superintendent of shops, who has resumed his duties as assistant superintendent of motive power and machinery.

O. C. Sandberg has been appointed superintendent of the Peru division of the Wabash Railway with headquarters at Peru, Ind., succeeding **W. H. Eckard**, deceased.

B. Koontz has been appointed supervisor of passenger locomotive operation on the Virginia & North Carolina division of the Seaboard Air Line with headquarters at Raleigh, N. C. **W. C. Rogers** has been appointed supervisor of passenger locomotive operation on the South Carolina division with headquarters at Savannah, Ga.

F. A. Starr has been appointed supervisor of reclamation of the Chesapeake & Ohio Railroad with headquarters at Richmond, Va.

Dwight S. Brigham has been appointed assistant general manager of the Boston & Maine Railroad with headquarters at Boston, Mass.

J. G. F. Moale has received promotion from the position of chief clerk to the superintendent of transportation of the Southern Pacific Company to that of car service agent with headquarters at San Francisco, Calif.

J. W. Fox, formerly right of way engineer of the Florida East Coast has been promoted to the position of assistant to the vice-president in charge of valuations, with headquarters at St. Augustine, Fla.

J. D. Walker has been promoted to superintendent of the Southern division of the Colorado & Southern Railways with headquarters at Trinidad, Colo.

John Rourke has been made general superintendent of the Boston & Maine Railroad and **F. H. Flynn** has been made superintendent with headquarters at Concord, N. H., succeeding **S. E. Miller**, who was made general superintendent of transportation; **John A. Ahearn** becomes superintendent with headquarters at Greenfield, Mass. **F. C. Mayo** becomes superintendent with headquarters at Woodsville, N. H., and **W. H. Towne** becomes assistant to the general superintendent with headquarters at Boston, Mass.; **H. E. Folsom** retired as general superintendent of the second district.

A. W. Ames has been appointed roundhouse foreman of the coast line of the Atchison, Topeka & Santa Fe Railway with headquarters at Seligman, Ariz., succeeding **F. H. Truxler** who has been made division foreman with headquarters at Ashfork, Ariz. **Harry Whitman** has been appointed division foreman of the Santa Fe shops at National City, Calif., succeeding **Edward Leonard**, who has been made general foreman with headquarters at Prescott, Ariz., succeeding **Harry Whitman**, transferred.

Ralph E. Dowdell has been made superintendent of the Boston & Maine Transportation Company, operating the bus division of the Boston & Maine Railroad, Portsmouth, Mass., succeeding his father, **W. E. Dowdell**, who died recently.

Daniel J. McBride has been made boiler shop foreman of the Coast Line division of the Atchison, Topeka & Santa Fe Railway, with headquarters at Prescott, Ariz., succeeding **Harrison Brown**, transferred to Winslow, Ariz.

Supply Trade Notes

H. G. Mastin has been appointed representative in the sales department of the **Locomotive Stoker Company**, Eastern district, with headquarters in New York City.

Mr. Mastin was born on December 23, 1887, in Millbrook, Dutchess County, New York, and received his education in Millbrook High School. He entered the employ of the New York, Ontario & Western Railroad as locomotive fireman in 1906 and remained in that service until 1908, when he was promoted to traveling fireman and assistant road foreman of engines on the southern division.

Mr. Mastin remained with the New York, Ontario & Western until entering the service of the Locomotive Stoker Company in October, 1918, as mechanical expert, which position he occupied at the time of receiving his present appointment.

V. B. Emrick has been appointed a representative of the **Locomotive Stoker Company**, with headquarters in Chicago. Mr. Emrick was born at Delphi, Ind., on August 3, 1889, and received his early education in the public schools in Delphi. He later took a course in engineering, after which he entered the employ of the Albuquerque Eastern, at Albuquerque, N. Mex., doing locating work in connection with the building of that road out of Albuquerque. He then went to the Atchison, Topeka & Santa Fe, Coast lines, as a fireman and later served as an engineman. In December, 1920, he was appointed mechanical expert of the Locomotive Stoker Company, working out of the Chicago office, which position he held at the time of his present appointment in the commercial department.

L. C. Sparks, formerly in the engineering and sales departments of the **American Car & Foundry Company**, with headquarters in New York, has opened an office in 1005 Federal Commercial Trust building, St. Louis, Mo., to handle railway and industrial supplies.

The Railroad Supply Company, Chicago, Ill., announces the purchase of the Bryant Zinc Company. **E. H. Bell** will continue as president of the Railroad Supply Company and the official personnel will remain the same.

Joseph T. Ryerson & Son, Chicago, have taken over the full right covering the manufacturing and sale of the horizontal drilling and boring machine manufactured by the **Harnischfeger Corporation**, Milwaukee, Wis.

The General American Tank Car Corporation, Chicago, Ill., has established southern sales office at 1022 Union Indemnity building, New Orleans. **Z. R. Simon** will be in charge as southern sales manager.

The Chicago Tank Car Company has been incorporated with $100,000 capital to build tank cars, and will have headquarters in the Railway Exchange building, Chicago, Ill. The organizers include **G. L. Weaver, M. C. Putnam** and **J. J. Sherlock**.

The American Car & Foundry Company has acquired control of the **Hall-Scott Motor Company** plant, which is located at Oakland, Calif., and which manufactures motors for the **Fageol Motor Company.**

E. E. Cullison has been appointed special representative of **Pratt & Whitney Company**, with headquarters at Altoona, Pa.

The National Lock Washer Company has moved its Chicago offices from the Lytton building to 1103 Straus building.

Victor W. Ellet has been appointed sales manager of **Hunt-Spiller Manufacturing Corporation**, with headquarters at Boston, Mass., to succeed **John C. Platt**, whose jurisdiction as vice-president has been extended to cover operation as well as sales.

James E. Key, formerly superintendent of the **Westinghouse Air Brake Company**, has become an instructor in the industrial engineering department of the Pennsylvania State College.

The General Electric Co. plans the construction of a large warehouse and office building in Los Angeles, Calif., to cost approximately $1,000,000, and to be located at Santa Fe Avenue and 52nd Street.

John T. Llewellyn has been elected president of the **Chicago Malleable Castings Company**, succeeding **S. J. Llewellyn**, who died at his home in Evanston, Ill., on September 3. **Paul Llewellyn** has been elected vice-president-secretary.

Nathan L. Miller has been appointed general counsel and a director of the **United States Steel Corporation**, and **Myron C. Taylor** has been elected a director of that corporation.

The General American Tank Car Corporation, Chicago, Ill., has purchased the properties of the **Lone Star Tank Company**

at Fort Worth and Wichita Falls, Texas, and will use the facilities acquired for the manufacture and repair of tank cars.

The Cummings Car & Coach Company has been incorporated in Chicago, Ill., with $200,000 capital, to manufacture railway appliances.

L. D. Brown, treasurer of the **B. F. Goodrich Co.**, has been elected vice-president and treasurer of that company. **H. Hough**, controller, has been named vice-president and controller. Both men have been connected with the Goodrich organization for a number of years.

J. G. Foote has been appointed acting sales agent of the **Bethlehem Steel Company** in the Cincinnati district. **F. A. Scammell** has been appointed assistant general manager of the **Cambria Steel Works**, succeeding **R. J. Wysor.**

E. H. Wood, former master car builder on the Michigan Central Railroad, has joined the sales forces of the **Grip Nut Company** in the capacity of district sales manager, and will have his headquarters in Chicago, Ill.

Carl S. Jordon, who has been serving as assistant to the manager of railroad sales of the **Wyoming Shovel Works**, has been transferred to San Francisco, Calif., where he will have charge of the California territory as district sales manager. He will be succeeded by **M. S. Hendrickson**, who will be located at Chicago.

The Linde Air Product Company has placed a contract covering a one-story branch plant at Roanoke, Va., with **J. P. Pettyjohn & Company,** Lynchburg, Va.

G. H. Woodroffe has been appointed metallurgical engineer, a newly created position of the **Reading Iron Company,** boiler tube department, at Reading, Pa. Mr. Woodroffe has been closely associated with the iron and steel industry over a period of many years, serving as engineer of tests during the last five years of a nine years' service with the **Baldwin Locomotive Works,** and since 1917 he has been mechanical and metallurgical engineer for the **Parkersburg Iron Company.** Mr. Woodroffe is serving in an important capacity with the American Society for Testing Materials as secretary of Committee on Steel and is also a member of the American Society of Mechanical Engineers.

The Union Switch & Signal Company, Swissvale, Pa., announces that it has acquired the assets of the **Hall Switch & Signal Company.** The manufacture of the apparatus heretofore furnished by the Hall Company will be continued by the Union Switch & Signal Company. The Hall Switch & Signal Company organization will be continued for the present without change.

John L. Crouse, formerly manager of the development and supply division of the railway sales department of **Westinghouse Electric & Manufacturing Company,** has been appointed as assistant to the manager of the railway department. He has served the Westinghouse company for the past 32 years. **A. B. Gibson**, for the past six years manager of the Westinghouse Technical Night School, has been appointed to succeed Mr. Crouse as manager of the development and supply division.

Obituary

Edwin H. Baker, who retired as second vice-president of the Galena-Signal Oil Company in 1916, after having been engaged for 43 years in the manufacturing and supply of lubricating oils, died in Brooklyn on September 15. In 1873 Mr. Baker entered the employ of S. T. Baker & Company, New York, a concern manufacturing lubricating oils which had been founded by his father in 1849. S. T. Baker & Company was later incorporated and became a department of the Galena Company, and in 1894 Mr. Baker entered the services of the latter company, continuing at the same time as president of S. T. Baker & Company. In 1912 the Baker Company was consolidated with the Galena and Mr. Baker became second vice-president of the Galena-Signal Oil Company. He continued in this capacity until the time of his retirement in 1916.

John J. Hannahan, assistant to the president of the Locomotive Stoker Company, died at his home in Merriam Park, Minn., on September 4, after a brief illness. He had been an employe of the Stoker company since its inception, having entered the service in 1912. He was well known throughout the railway world on account of his long connection with the Brotherhood of Locomotive Firemen and Enginemen. Mr. Hannahan was past grand master of this organization at the time of his death.

Wm. H. Heulings, Jr., vice-president and general manager of sales for the J. G. Brill Company, died September 14, in Philadelphia, Pa., after a brief illness. Mr. Heulings has been identified with the Brill company since boyhood, starting in February, 1885, as a stenographer. He was transferred to the sales branch of the business at the age of twenty. He became assistant secretary of the company in 1901, and in 1903, assumed in addition the duties of general manager of sales. In June, 1914, he was also elected vice-president and held this joint responsibility at the time of his death. Mr. Heulings was born November 17, 1869, in Philadelphia, and received his education in the public schools of that city. He was deeply interested in the work of the American Electric Railway Association, and was a past president of the American Electric Railway Manufacturers' Association.

John H. Ohlsson, assistant general manager of sales of the J. G. Brill Company, died suddenly Thursday, September, 3, at his home in Philadelphia. Mr. Ohlsson was born in Brooklyn, N. Y., October 4, 1880. He started with the Brill company as an office boy. Through his diligence and perseverance he rose steadily in the Brill organization until finally he was appointed to the executive position which he held at the time of his death. From 1907 to 1912 he was secretary to the vice-president and general manager and then acting assistant to the general manager of sales from 1912 to 1919. In 1919 he was appointed assistant general manager of sales. He was a member of the various organizations related to the railway industry.

Railway and Locomotive Engineering

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A Diesel Electric Locomotive

Details of the Construction and Operation of an Oil-Electric Locomotive Built by the Baldwin Locomotive Works and Equipped with Westinghouse Apparatus

The Baldwin Locomotive Works has recently completed an oil-electric locomotive for experimental and demonstration purposes, using a Diesel type of internal combustion engine as a prime mover and employing electric equipment manufactured by Westinghouse Electric Manufacturing Co. Like other locomotives of its class the engine turns continuously in one direction and drives a generator which supplies the electric current for the operation of the motors.

The engine consists of twelve cylinders operating in pairs set at an angle with each other, and driving two shafts as shown in the vertical cross section. Each shaft carries a herringbone gear that meshes with a corresponding pinion on the generator shaft.

The cylinders are each 9¾ in. in diameter having a 13½ in. piston stroke. They are capable of developing 1,000 horsepower.

The electrical equipment consists of a direct current generator developing a current of 750 volts, and four railway motors connected to four of the six pairs of wheels in the trucks.

The locomotive is carried on two six-wheeled trucks, each having a wheel base of 12 ft. 8 in. with wheels 40 in. in diameter. The total wheel base is 38 ft. 4 in. and the overall distance over the couplers is 52 ft. 1¾ in. The cab is 34 ft. 4 in. long over all; it is 14 ft. 7 in. high above the rails and 10 ft. 5 in. wide. The total weight is 275,000 lb. of which 180,000 lb. or a little less than two-thirds is upon the driving wheels. The capacity of the fuel tank is 750 gallons, and the equipment includes air brakes, air sanders, electric headlights and automatic couplers.

The starting tractive force is 52,200, which gives a ratio to the weight on the driving wheels of 1 to 3.44.

Diesel Oil-Electric Locomotive Built by Baldwin Locomotive Works Equipped With Westinghouse Apparatus

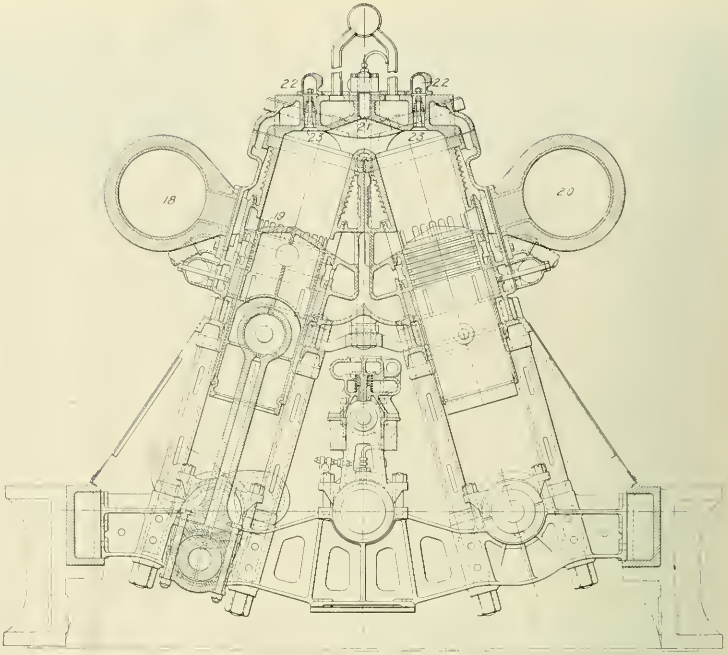
The main frame of the engine does not extend the whole length of the cab but has a total length of but 28 ft. or 2 ft. 4 in. more than the distance betwen the truck centers which is 25 ft. 8 in. The side sections of this frame are of cast steel, of channel section 20 in. deep with strengthening ribs at intervals. This frame serves not only as a base to carry the cab framing but as a foundation for the engine frames.

The truck frames are of the regular locomotive type, of cast steel with the usual pedestals and binders. The springs are placed over each oil box, the two inner ones, which are for the driving wheels are equalized together while the outer spring is attached to the frames at each end. A novelty has been introduced in these springs by making each of them one-half of the width required to carry the load and placing them in pairs on each side of the frame. By this means an essential and desirable lowering of the cab framing was accomplished.

The center lines of the cylinders incline outwardly from the top down at an angle of about 16 degrees with the vertical. The two shafts driven by the engine turn in the same direction and carry gears 29¼ in. in diameter that mesh with a pinion 11¼ in. in diameter on the generator shaft, so that the ratio of revolution of the two is as 1 to 2.6. Hence with the engine shaft running at a minimum of 480 revolutions per minute the generator shaft will be driven at a speed of nearly 1150.

The engine is a two-cycle machine, and the two cranks of each pair of cylinders are so set that one piston (that on the left in the illustration) is slightly in advance of the other. This is for the purpose of effecting a complete scavenging of the products of combustion.

The air for scavenging and compression is delivered through the pipe 18 under a gauge pressure of about 3 lb. per sq. in. As the left hand piston moves down, during the expansion it uncovers the ports at 19 and the scavenging air rushes in and sweeps across through and to the corresponding ports in the right hand cylinder and out at the exhaust pipe 20. Then, as the left hand piston is slightly in advance of the right hand one in its stroke, it closes the ports 19 before the corresponding ones are closed by the right hand piston. This causes the air to sweep over the top of the partition separating the two cylinders down through the right hand cylinder and out at the exhaust, thus thoroughly cleaning the contained air before the right hand piston closes the ports corresponding to 19.



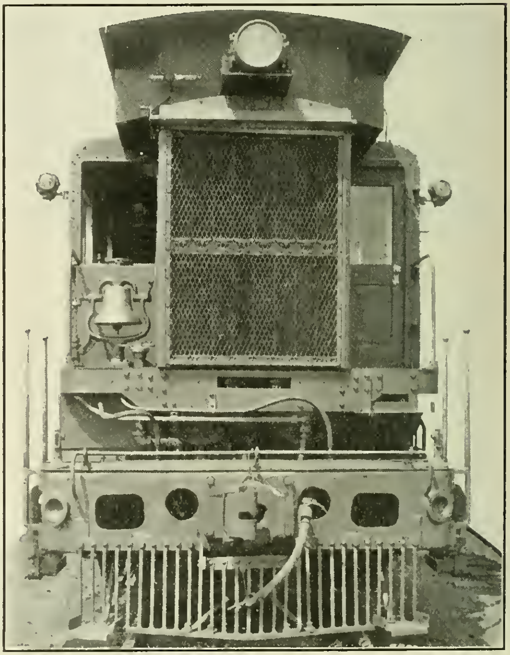
Cross Section of Diesel Engine of Baldwin Oil-Electric Locomotive

Both pistons then compress the air above them, and at the upper end of the stroke the injection takes place with the consequent explosion. The injection is what is known as a solid fuel injection and takes place at 21 through four holes made with a No. 70 drill. Their lines of direction are in pairs directed outwardly towards the heads of the pistons.

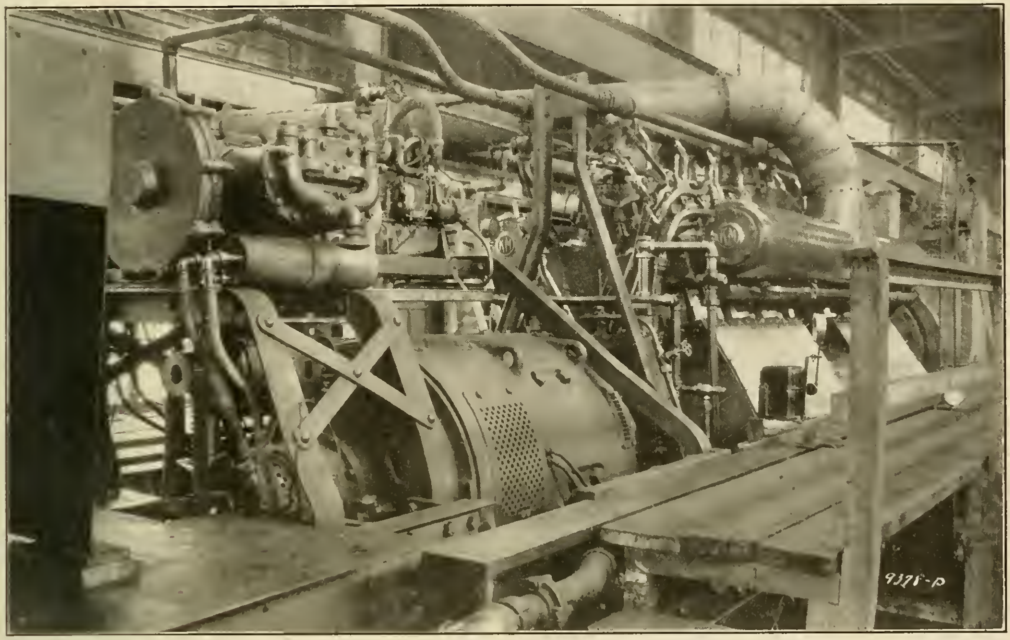
The engines are started by means of compressed air furnished by a special compressor and admitted by a cam operated valve at 22. This air passes down and opens the valve 23 against the tension of the spiral spring that holds it against its seat. As this valve is normally held closed by the spring as well as by the pressure developed by combustion in the cylinder the starting effect of the compressed air is automatically cut off immediately there is an explosion in the cylinder.

The speed of the engine is varied according to the requirements of the work that is demanded of the motors. This is accomplished by the manipulation of the throttle which is made independently of the movement of the controller handle. Smooth acceleration is thus obtained and the maximum tractive effort developed up to the slipping point of the drivers.

The method of delivering the oil to the cylinders in varying proportions dependent upon the speed of the engine and the work which it is called upon to perform is interesting and unique.


Front View of Baldwin Oil-Electric Locomotive

The speed of the engine with the resultant current development is controlled by a governor of the ordinary centrifugal ball type, whose balls are made to act against a helical spring whose tension can be varied. The greater is pivoted at *D* and, as the lower end is moved to the left its upper end compresses the governor spring *E*. It is evident, then, that the greater this compression, the higher must be the rate of revolution of the shaft *G* in



Diesel Engine of Baldwin Oil-Electric Locomotive

the tension that is put upon the spring the higher will be the velocity of rotation of the balls before a cutting off of the oil supply will take place.

The arrangement is shown diagramatically by the engraving of the control arrangement. In this there is an oil pump *A* deriving its supply from the tank *B* and delivering it, under pressure, through the central pipe of the system to the needle valves at either end of the car. The needle valve is adjusted so that a proper pressure will be maintained in or against the control valve.

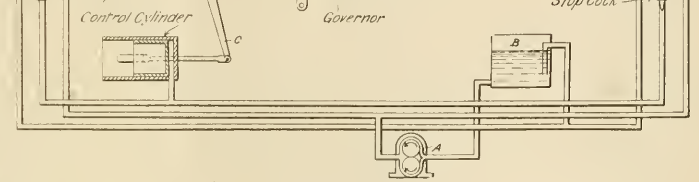
In the diagrammatic arrangement the control valve is shown in the holding position at the right hand end of the engine. That is to say the entrance of the delivery pipe is blanked and no oil can enter the valve.

At the left hand end of the engine, the control valve is shown as connecting the delivery pipe with the central pipe which has a branch leading from it to the end of the control cylinder. It will be seen that the corresponding pipe leading from the control valve at the other end of the engine is blanked.

With pressure admitted to the right hand end of the control cylinder, the piston is moved to the left, and carries the lower end of the lever *C* with it. This lever

order that the governor balls *F* may move outwardly, and by a further compression of the spring so move the lever *H* as to affect the fuel delivery apparatus at *I*.

If the handle of the control valve is moved to the de-

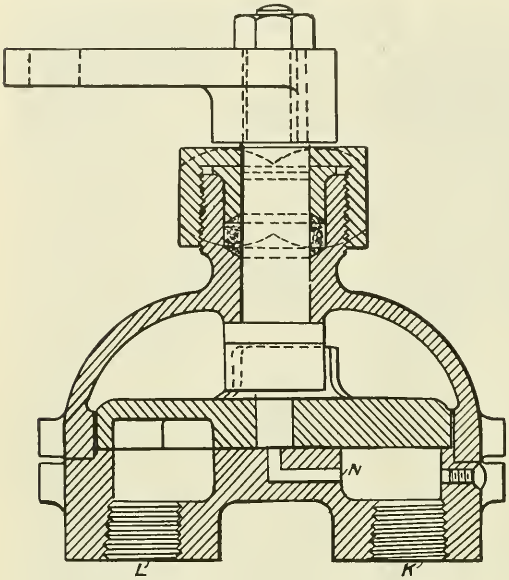


Diagrammatic Representation of Oil Supply Control of Baldwin Oil-Electric Locomotive

crease position, as indicated by the dotted lines, the cavity of the valve will connect the pipe leading to the control cylinder with the one entering the valve at the left, permitting the oil to flow back through the lower pipe to the supply tank *B*.

The construction of the control valve is shown in vertical section and also with its valve face in the three positions of "increase," "holding" and "off."

To all intents and purposes it is merely a balanced disc valve operating as a three-way cock.

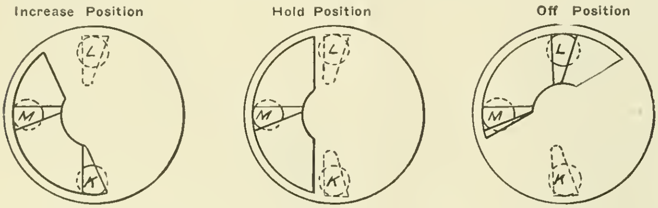


Oil Control Valve of the Governor

The delivery or supply pipe is connected at *K*, the exhaust pipe at *L* and the pipe to the control cylinder at *M* (not shown in the vertical section.)

Oil entering under pressure at *K* flows through the small hole *N*, in the seat up through the center of the valve to the space in the casing above it. Here, acting upon the whole area of the disc of the valve, it holds it firmly to its seat.

The three main positions of the valve are clearly shown. In the increase position the oil enters at *K*, flows through the cavity of the valve and out at *L*, thence to the control cylinder. In the hold position, both the supply and exhaust openings are blanked, and the piston of the control cylinder is held in place. With the valve in the "off" position, the oil flows back through *M* to the exhaust opening *L* and the tension on the governor spring is re-

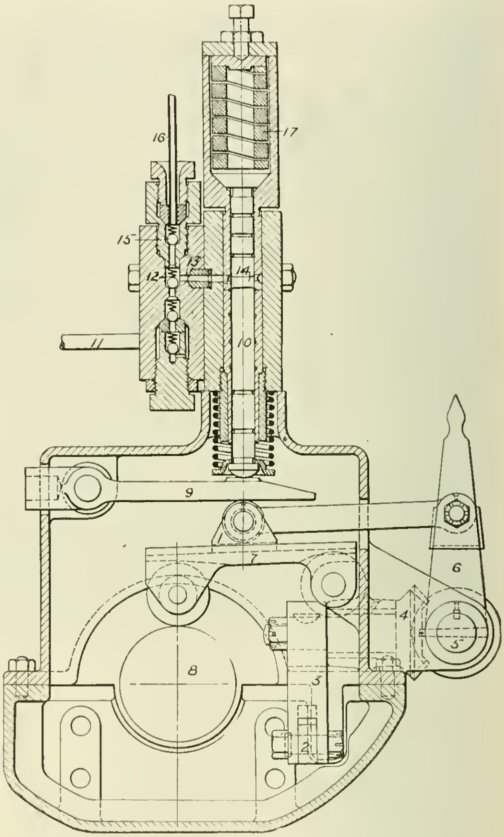


Seat of Oil Control Valve of Governor

laxed, so that it can resume its normal position and the governor effect reduction of the oil feed to the cylinders at the minimum speed of rotation.

The fuel pump indicated at *I* in the diagram of the control arrangement is shown in detail by a special engraving of a vertical section of the same; the actual construction being somewhat different in detail though not in principle from that of the diagram.

Instead of a direct connection between the lever at



Fuel Pumps for Oil-Electric Locomotive

the right of *I* and the slide 1, the attachment is made at 2, at the lower end of the lever 3, which is fastened to the same shaft as the miter gear 4. The mate of this gear is keyed to the shaft 5, and as it turns the arm 6 is moved to and fro and, with it, the slide 1.

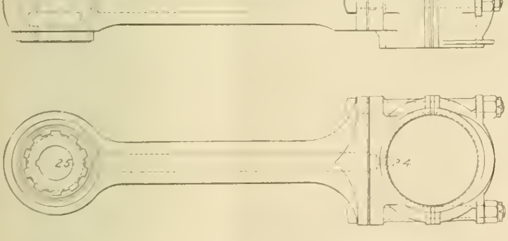
This slide moves back and forth on the cam arm 7 which is raised and lowered at the proper moment by the rotating cam 8. As the cam arm is raised it lifts the arm 9 and, with it, the plunger 10 of the pump. The latter is held down against the arm 9 by the helical spring as shown.

With the governor balls retracted the slide is directly beneath the center of the pump plunger and the latter is given its maximum stroke. As the speed of the engine increases the governor balls fly outward and the slide is drawn to the right thus decreasing the stroke of the pump plunger, and forcing less oil into the cylinders.

The oil is delivered to the pump under pressure through the pipe 11 and enters the casing below the lowest of the three ball valves. These balls are held against their seats by light springs that yield before the pressure of the oil and permit it to pass upward to the chamber 12, and thence it flows laterally through the passage 13 to the space 14 above the pump plunger. From the chamber 12, it also rises against the bottom of the upper ball valve 15, which is held against its seat by a spring having sufficient tension to prevent any further upward flow of oil at the pressure under which it is delivered. The whole space above the plunger is thus filled with oil and when the plunger is lifted by the cam an amount of oil corresponding to that lift, is forced past the ball 15 and up through the pipe and into the cylinder.

As a protection against the development of an excessively high pressure above the pump plunger a second plunger is placed in the cylinder above it, which is held down with a stiff spring 17, exerting a sufficient pressure to withstand that needed to deliver the oil into the cylinder.

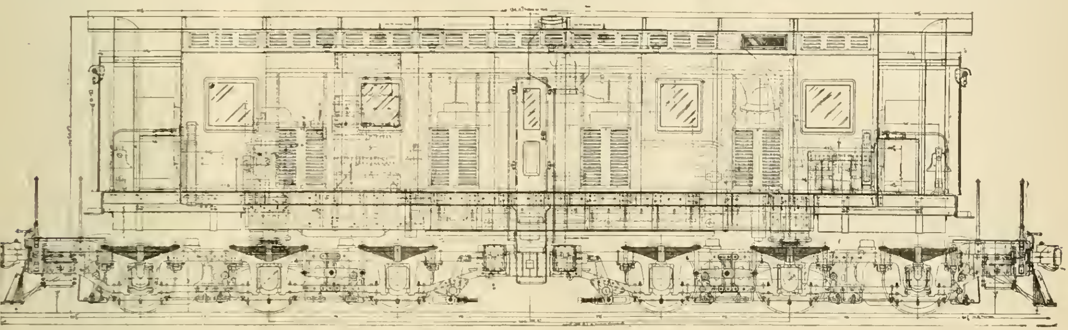
The method of lubricating the journals of the engine is simple and bold. Oil is delivered to the main bearing under a pressure of 7 lb. per sq. in. Thence it flows through the hollow shaft to the crank. Following a hole through the crank it reaches the hollow crank pin, the surface of which it lubricates through oil holes drilled in the same. After doing its work here a part of it enters the oil holes 24 in. the rod brass of the pin and is forced up through the whole length of the hollow connecting rod where it escapes at the oil hole 25 to lubricate the wrist pin.



Connecting Rod of Diesel Engine

Another item is the connection between the two sections of the generator shaft. The section carrying the driven pinion is connected to the generator portion by a Falk-Bibby spring coupling. This is in order to prevent sudden stresses being placed upon the shaft by the starting or rapid changes in the rate of rotation. This coupling consists of two flanges attached to the two lengths of shaft and connected to each other by flat plates of spring steel that have sufficient combined stiffness to drive the generator but which yield under the imposition of a suddenly applied load.

The cooling water for the cylinder is itself cooled by a centrifugal air cooler set at the ends of the locomotives, as shown by the illustration of the end view. This cooler is formed of a series of cells whose sides are formed of thin water passages through which the water is made to circulate, thus exposing a maximum surface to the cooling action of the air that is drawn through the open spaces of the cells. In order to obtain the maximum cooling effect of the air, the cells contain strips of thin metal twisted into the form of a helix, so that, as it passes through, it is given a whirling motion by which all of its particles are brought into contact with the cooling plates back of which the water is circulating.



Side Elevation of 1000-Horsepower Diesel Oil-Electric Locomotive

This engine has, thus far, been engaged in switching service on the Reading and Pennsylvania railroads and is expected to be put at work on a number of other roads in the course of the next few months. A record of its performance will be published in a future issue.

A.R.A. Adopts 39-Foot Rail Standard

As a further step to bring about increased economy in the operation of the railroads of this country, the American Railway Association has announced that new specifications have been approved by the organization by which the length of rails used by the railroads of this country is to be increased to 39 feet. This means an increase of six feet over the rail in present use although the weight per yard will continue to be the same.

By making an increase in the length of the rail, there will be a marked saving to the railroads in not only the cost of installation of new rail but also in the maintenance of the railroad track.

This increase in the length of the rail from 33 to 39 feet means a reduction of 16 per cent in the number of rail joints while it also will mean a saving of about one-sixth of the total amount of expenditure required for bolts, nuts, joint bars and spring washers used in connecting rails together.

It is estimated that 5c out of each dollar spent for track maintenance goes for maintenance of joints, ties and ballast under the point where two rails are joined together. This increase in the length of the rail, therefore, will mean a saving of about 16 per cent in such expenditures as there will be fewer joints.

The Locomotive Testing Plant and Its Influence on Steam Locomotive Design*

By Lawford H. Fry

No study of locomotive development and operation can be complete without consideration of the work done by the locomotive testing plant at Altoona, as the results of this work have materially influenced locomotive design not only in this country, but abroad. Rowland is designing locomotive boilers in England according to formulas developed largely from test data from the Altoona plant, and his formula for efficiency of combustion had been adopted by the Railway Board of India as a basis for their official method of estimating boiler capacity.

The locomotive testing plant is purely of American origin, and no real plant of the kind has been built outside of the United States.

Of the six plants that have been built, the two of the Chicago & Northwestern Ry. and that of Columbia University have been abandoned and the original one at Purdue University was destroyed by fire, leaving the present Purdue University plant and those of the Pennsylvania R. R. and of the University of Illinois.

The widest range of work has been done on the Pennsylvania and Purdue plants.

Writing in 1904 of the information contributed by the Purdue plant, Dr. Goss pointed out that the plant had thrown light on the factors limiting indicated horsepower and rates of combustion which were previously imperfectly understood; that it had shown how the relation between cut-off and steam consumption varied with the speed; and that it had been used to study the action of the exhaust in producing draft and had thus assisted in determining the best proportions for locomotive front ends.

The early work done at the plant consisted in operating the 4-4-0 type locomotive under varying conditions of speed and load. The information obtained was general in character and bore chiefly on variations in tractive force and steam consumption as affected by changes in speed and cut-off. The effect of rate of operation on boiler efficiency was also studied, but as smokebox-gas analyses were not made, no great progress resulted in this direction. A considerable body of definite information was made available, which was undoubtedly of general value to locomotive designers in determining correct size for locomotives to perform a given service, and in securing a proper balance between cylinder power and boiler capacity, but such information was merely supplemental to much of a similar nature that had been secured by road tests and no basically new information was brought to light. The front-end and stack tests, however, covered research work which could not have been carried out except at a locomotive testing plant. Certain principles previously unknown were brought to light and American locomotive design was definitely affected. It was shown that a tapered stack was preferable to a straight one, and that while a draft pipe would improve the action of a stack which was too small, no combination of draft pipe and stack would give better results than a properly proportioned stack without a draft pipe. It was also shown that the draft-producing action of the exhaust steam was independent of the intermittency of the exhaust, the essential factor in the suction produced being the quantity of steam exhausted. This last fact has been confirmed by all later test-plant results but is often overlooked, particularly when the claim is made that a multi-cylinder locomotive gives a more efficient exhaust action. The results of the various front-end tests were embodied in a series of equations indicating the best proportions for stack and front ends. These equations, while largely empirical, provided a logical basis for the design of the front end and had a considerable influence on American locomotive practice.

In the series of tests made on the Pennsylvania plant, when it was installed at the St. Louis Exposition in 1904, far more complete data was obtained than any previously available. They furnished for the first time, sufficient information to enable heat balances to be drawn up for a locomotive boiler, and gave, for the first time, exact knowledge as to the relative importance of the various losses which determine its efficiency.

Among the definite contributions made by this plant since its transference to Altoona, are:

The development of a self-cleaning front end, with a nozzle, diaphragm and stack arrangement which gives better results than that of the Master Mechanics' Association.

The determination that with an underfeed stoker a free air space of one square foot should be allowed for each 1900 lb. of water evaporated per hour.

That a short tube gives free steaming or rapidity of evaporation at the expense of efficiency, so that the most desirable tube length is found by practical considerations as a result of balancing steam production against boiler efficiency. On this basis and taking into account details of construction the Pennsylvania Railroad adopted as standard for 2-in. tubes a length of 15 ft. or 102 inside diameters, and for 2¼-in. tubes a length of 19 ft. or 113 inside diameters. The conclusions arrived at were checked against and found to be substantially in accord with those derived from the early experiments made by M. A. Henry on the Paris, Lyons & Mediterranean Ry. with much lower rates of evaporation. It was also established that the rate of evaporation is determined by the weight of gases passed over the heating surface and is limited by conditions of combustion and not by a failure of the heating surface to absorb heat.

The maximum rate of evaporation was established as 7000 lb. of water per hour per square foot of fire area of the tubes.

It was shown that for piston valves a diameter of 12 in. was sufficient for cylinders up to 27 in. in diameter when using superheated steam, and subsequent tests showed that valves of this diameter could be used with 30-in. cylinders with cut-off limited to half-stroke. Measurements of the stresses in the valve stems gave definite figures showing the great advantage in lightened valve gear to be secured by using valves of the minimum size.

An extensive series of experiments on superheaters produced data which are summed up in Fig. 1, which shows engine steam consumption for varying conditions of superheat, cut-off and speed.

In the case of one type of engine it was recommended: that a change from the circular form be made in the exhaust nozzle; that a screw reversing gear be used; that the cylinders be so enlarged that the maximum horsepower could be developed at a cut-off not exceeding 30

*Abstract of paper read before the American Society of Mechanical Engineers, October, 1925.

per cent of the stroke; that the tube lengths be increased; that 12-in. diameter piston valves be used and that the width of the center grate bearer be reduced.

Tests of a locomotive redesigned along these lines gave an increase of 15 per cent in the maximum evaporation, combined with a boiler efficiency 9 per cent better than that of the original engine. At the same time the engine performance was generally better, so that a higher drawbar pull was developed at all speeds and the maximum drawbar horsepower was increased over 20 per cent. These advantages were secured with an increase in total weight of only 2.5 per cent. Careful design of the reciprocating parts enabled them to be kept down in weight so that the dynamic augment at 70 m.p.h. was less than 30 per cent of the static load on the drivers.

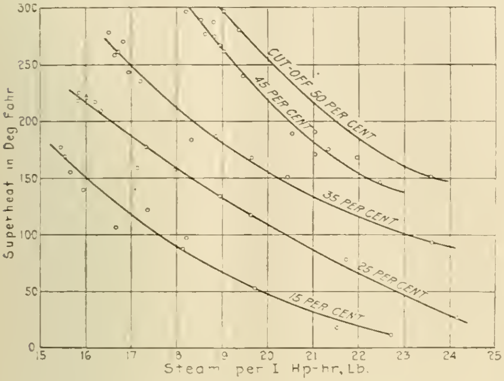


Fig. 1 Effect of Superheat on Steam Consumption at Various Speeds and Cut-Offs

Tests were made with a Pacific-type locomotive built in 1914 in accordance with recommendations and experience obtained with locomotives of earlier designs on the testing plant. The coal and water rates and the high thermal efficiency showed this to be the most economical passenger locomotive tested up to that time.

Tests showing the great difference in steam consumption between locomotives operated at full and half stroke cut-off, led to the design of a class of locomotives having a boiler pressure of 250 lbs. per sq. in. instead of 205 lbs. and with cylinders so enlarged as to enable full power to be developed with a cut-off of not more than 50 per cent.

Compared with the previous standard freight locomotive the new engine, with an increase of 16 per cent in weight gave an increase of 25 per cent in power, and in full gear, at low speed showed a reduction of 38 per cent in steam used per indicated horsepower. This type of locomotive with feedwater heater added, which gave a further increase of 10 per cent in indicated horsepower, is now the standard freight engine on the Pennsylvania System.

While a majority of the tests have been made for the purpose of obtaining information to be used in the improvement of the design tested, many have been analyzed and correlated so as to enable general conclusions to be drawn. Among these is the establishment of a rate of evaporation of 7,000 lbs. of water per hour per sq. foot of fire area in the tubes. If the size and style of flue are unchanged, the relations between fire area, heating surface, evaporation, and boiler efficiency may be summed up as follows:

a An increase in heating surface without an increase in fire area means an increase in tube length. This will give a slightly greater boiler efficiency, but the evaporation will be increased only very slightly, if at all, as owing to the greater resistance which the longer tubes offer to the gases it will not be possible to increase the amount of gas taken through the boiler.

b An increase in fire area without an increase in heating surface means an increase in the number of tubes with a proportionate reduction in tube length. Any considerable change in this direction will give a considerable increase in evaporative capacity, because the increased fire area and reduced resistance in length will enable a considerably greater weight of air to pass through under the same draft. At the same time the shortening of the tubes will entail a slight reduction in efficiency.

c If a boiler working below its maximum capacity is considered, the fire area may prove to be less important than is indicated above. Take, for example, a boiler fired at the rate of 80 lb. of coal per sq. ft. of grate while the maximum capacity is not reached with less than 120 lb. per sq. ft. of grate area. With an efficient front end it would probably be possible to block up 20 per cent of the flues and still to draw the same amount of air through the boiler. The fire area would be reduced 20 per cent, but combustion would be at the same rate and the efficiency of heat absorption in the flues would be affected only to the extent of 1 or 2 per cent. The number of tubes being reduced, the amount of gas passing through each tube is increased. The increase in the rate of flow increases the rate of heat transfer so that the heat taken up by each flue is increased, and the total amount taken up is practically the same in spite of the reduction in the number of flues acting.

As to the increase in the size of locomotive the standard passenger locomotive of 1904 was a 4-4-2 weighing 185,000 lbs. with a maximum indicated horsepower of 1200 burning 6,000 lbs. of coal per hour. In 1914 the 4-6-2 locomotive weighed 309,000 lbs., developed 3300 horsepower and burned 10,000 lbs. of coal per hour, with an increase of 65 per cent in the indicated horsepower per hour, and a decrease from 5 to 3 lbs. of coal burned per indicated horsepower per hour.

For freight locomotives the improvements made from 1904 to 1923 was first a change from the 2-8-0 to the 2-10-0 type, an increase in weight from 175,000 lbs. to 386,000 lbs.; an increase from 1,000 to 3,530 horsepower; an increase in the amount of coal fired per hour from 4,500 lbs. to 12,800 lbs. per hour; an increase of 60 per cent in the horsepower developed per 1,000 lbs. of weight and a reduction in coal burned per indicated horsepower per hour from 4.5 to 3.6 lbs.

As an illustration of the information which can be derived from test plant data by further analysis there is given a brief account of some work which the author has undertaken recently in connection with a study of locomotive boiler efficiency.

In all tests of locomotive boilers in which the boiler efficiency is measured over a considerable range of rates of firing it has been found that as the rate of firing increases there is a drop in boiler efficiency which can be represented best by a straight-line law. In Fig. 2-C the lines found for the Pennsylvania Railroad 4-6-2 passenger and the 2-10-0 freight locomotive are shown. The boiler efficiency here is the heat taken up by the boiler in evaporation and superheating expressed as a percentage of the heating value of the coal fired. The value found for this efficiency at any given rate of firing is dependent on three factors:

1. The efficiency of combustion, which is the efficiency with which the coal is burned in the firebox. In other

words, the amount of heat actually produced in the firebox expressed as a percentage of the heating value of the coal fired.

2. The efficiency with which the heat produced is taken up by the boiler.

3. The amount of heat taken up by the boiler which is lost by external radiation. In the absence of exact information the author assumes this external loss to be 5 per cent of the heat utilized in evaporation. This assumption has been justified by the results obtained.

Now from the data secured at the locomotive testing plant it is possible to separate the overall boiler efficiency

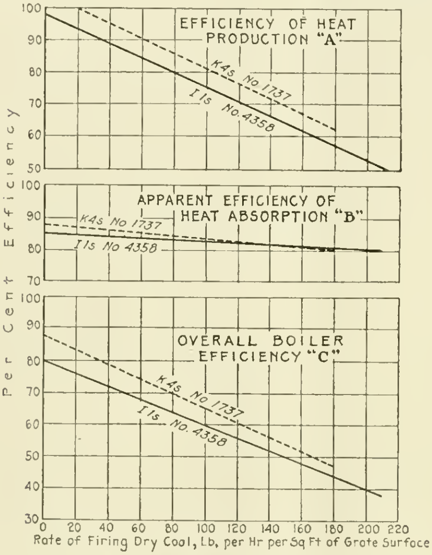


Fig. 2 Locomotive-Boiler Efficiencies in Relation to Rate of Firing

into its component factors. This being done for the boiler efficiencies shown in Fig. 2-C, the lines shown in Figs. 2-A and 2-B represent respectively the efficiencies of combustion and heat absorption. Numerical values for the three efficiencies at representative rates of firing are given in the table.

Table Locomotive-Boiler Efficiencies

Locomotive	Rate firing, lb. per sq. ft. grate per hr.	Efficiency of heat production, per cent	Efficiency of heat absorption, per cent	Overall boiler efficiency, per cent
K-4s	80	86.0	85.5	70.0
	120	76.5	83.5	61.0
	160	67.0	81.5	52.0
I-1s	80	79.7	84,4	64.0
	120	70.6	83.2	56.0
	160	61.5	82.0	48.0

These figures are not offered here for the purpose of making a detailed comparison of the two locomotives, but are given as representative of the results obtained in good locomotive practice. It is chracteristic of the locomotive boiler to show efficiency relations generally similar to those in the table. The efficiency of heat absorption shows high values which remain nearly constant, being little affected by the rate of firing. The efficiency of combustion shows a large variation with the rate of firing. At low rates the efficiency is very close to 100 per cent, but falls rapidly as the rate of firing is increased. At a normal maximum rate of 100 to 120 lb. per square foot of grate per hour the efficiency of combustion is in the neighborhood of 60 per cent, while if the boilers are pushed to actual maximum power the efficiency falls to less than 50 per cent. The efficiency of heat absorption is, as has been said, much more uniform, never dropping below 80 per cent at the highest rate of firing and showing values of about 86 per cent at low rates of firing.

Now it is evident that if the overall efficiency of the boiler is to be improved it is desirable to study closely the two component efficiencies. In the first place, it is noted that at normal rates of firing the efficiency of combustion is in the neighborhood of 60 per cent, and the efficiency of heat absorption is over 80 per cent. This indicates that there is a greater margin for improvement in combustion than in absorption. In reality, the possible margin for impovement in absorption is even less than would appear from these figures, for while it is possible to have 100 per cent efficiency of combustion with low rates of firing, it is not physically possible for the efficiency of heat absorption to have a higher value than about 91 per cent. This follows because it is physically impossible, even under ideal conditions, for the boiler to take up all of the heat produced in the firebox. Under no conditions is it possible to cool the smokebox gases below the temperature of the saturated steam in the boiler. With a boiler pressure of 205 lb. per sq. in. this gives an ideal minimum temperature of 390 deg. fahr. for the smokebox gases, at which temperature each pound of gas will carry 96 B.t.u. Under normal conditions the production of one pound of combustion gases will be accompanied by the liberation of approximately 1080 B.t.u., and with an atmospheric temperature of 65 deg. fahr. adding a further 13 B.t.u., the total heat offered to the heating surface will be approximately 1093 B.t.u. per pound of gases of combustion. With ideal conditions by which the gases of combustion were cooled to the saturated-steam temperature, 96 B.t.u. would be left in, and 997 B.t.u. absorbed from, each pound of gas. That is, under ideal conditions the heating surface cannot possibly take up more than 91 per cent of the original heat in the gases. Let us designate as "apparent efficiency" the efficiency of heat absorption based on heat produced, and designate as "real efficiency of absorption" the heat taken up expressed as a percentage of the heat absorbable under ideal conditions. Then while the figures above show "apparent" efficiencies of heat absorption ranging from 80 to 86 per cent, the "real" efficiencies range from 94 per cent at low to 88 per cent at high rates of firing. It is evident that as a piece of heat-interchange apparatus the modern locomotive boiler, as exemplified by the Pennsylvania Railroad boilers in question, is highly efficient and that there is but a small margin for improvement in heat absorption.

The efficiency of combustion shows a different condition. Here an efficiency of 100 per cent is possible and is shown by the tests to be reached at low rates of combustion. At the usual rates of operation, however, the values are generally in the neighborhood of 60 per cent or less.

There is evidently considerable field for improvement here, but it must not be assumed that improvement is easy. There is yet room for considerable study before the final answer is given. The diagrams show that boiler efficiency can be improved by reducing the rate of firing per square foot of grate. If the same power is to be maintained, this means an increase in the size of grate so that the total amount of coal burned may be maintained. Locomotive designs adopted by various railroads in the last few months show development along this line, but as yet no testing-plant analysis of performance is available.

In this connection the author calls attention to the fact that in the discussion of boiler efficiency in relation to rate of operation it is usual, as has been done above, to measure the rate of firing in terms of coal per square foot of grate per hour. This assumes that the grate area is the controlling factor in determining the efficiency of combustion. Grate area is an important factor, but not the only one. Firebox volume must also be considered. The test-plant data are not yet sufficiently complete to permit a determination of the relative values of grate area and firebox volume, but one series of tests with high-volatile coal suggests that with this fuel the volume is the more important. The point deserves more study and it may be found that combustion efficiency can be best improved by a slight increase in grate and a considerable increase in firebox volume with appropriate arrangement for giving a long flame-way.

The question is extremely complex and can be most adequately answered by further test-plant work. Doubtless this is but one of many problems by the solution of which the locomotive testing plant will advance still further the development of the steam locomotive.

For the future we look with confidence for a continued growth in the use of the locomotive testing plant. The great increase in locomotive efficiency which has been seen to have taken place in the last twenty years makes further advance more difficult, and makes exact knowledge a necessary condition for such advance. As it is the function of the locomotive testing plant to provide exact knowledge, it is not surprising that new plants are under consideration by railroads and by locomotive builders. A very great step forward could be made if the American Railway Association were to construct or to take over a locomotive testing plant to be devoted to the scientific and impartial study of locomotive designs and devices, and to undertake research work concerned with the basic scientific laws governing locomotive operation. Correct locomotive design is based on definite natural laws, knowledge of which can be obtained only by accurate experiment. The great influence which the locomotive testing plant has had on locomotive design is due to the opportunity it has given for thorough and accurate study of the fundamental laws governing locomotive operation. It it evident that the wider and the more accurate the knowledge a designer has regarding the laws governing the operation of his product, the more confidently and the more successfully can he proceed with improvements in design.

Integrity of Capital Accounts

Effected by Depreciation Charges—Salvage and Scrap Credits

FOURTH ARTICLE

By W. E. SYMONS

In the three previous articles in Railway and Locomotive Engineering under the caption of: "Working Capital vs. Idle Money or Frozen Accounts," the items of Material, Supplies and Cash on hand, have been under special consideration and attention directed to the possibilities of effecting great economies through a more judicious use or handling of these particular items, and while it is true that a dollar lost or saved, no matter whether stolen from the cash drawer or wasted in unnecessary material investments, or dissipated or lost through gradual service or wear of a unit of physical property without making proper depreciation charges to operating expenses, the net result in either case is, 100 cents of the shareholders' money is gone, and to that extent the integrity of the company's capital account has been impaired.

Depreciation Charges—Salvage and Scrap Credits to Equipment Accounts

As a general rule or fundamental principle it may be stated that in order to properly protect and preserve the integrity of the shareholders' investment in locomotives and cars, they should be kept in good physical condition at all times available for service except when in shops undergoing such repairs as made necessary by service rendered, and in addition to the cost or expense of maintenance there should be set up a depreciation fund against the purchase price or ledger value to which should be credited each month and charged to operating expenses, an amount equal to one twelfth of the annual rate of depreciation based on the estimated normal life of the equipment.

The Transportation Act of 1920 directed the Interstate Commerce Commission to fix uniform rates of equipment depreciation to be used by carriers, and while much progress was made in this direction, yet since Federal control ended on March 1st, 1920, the carriers employ different rates, as will be seen by the following table which is used by certain of our leading trunk lines.

Name of Company	Locotives Per Cent	Passenger Cars Per Cent	Freight cars Per Cent	Work Equipment Per Cent
Atlantic Coast Line	3	2	3	2
*Erie R. R.	3	3	4	4
‡Del. & Hudson Co.	2	2	2	2
Illinois Central	4.11	4.10	4.62	4.21
‡Great Northern	2	2	2	2
Northern Pacific	4	4	4	4
New Haven	3½	3½	4	4
‡N. Y. Central R. R.	2½	2½	2½	2½
(a) Pennsylvania	4	4	4	4
Seaboard Air Line	2	2	2	2
Southern Pacific	3	4	4	5
‡Union Pacific	3.44	3.73	4	4.20

*Roughly, basis is cost less salvage value.
‡Original cost and 4½% from 1918.

Table Showing Rates of Depreciation Charged by Various Carriers

While the wide range of average normal life of equipment as shown in the above table is noteworthy, running as it does from 20 to 50 years, yet, three of the roads with lowest depreciation charges have increased the amount on new equipment to 4½ per cent since 1918, which plan, if adhered to, would automatically raise their rate of charges to this account.

Depreciation charges on equipment should cease when the difference between the ledger value and the estimated scrap value shall have been credited to the accrued depreciation account. When this has been done the shareholders' dollar is absolutely preserved intact.

In order to more clearly bring out the essential features of this question, and make it more thoroughly practical to the student as well as those more versed in statistical or accounting matters, a tabulation has been prepared on 16 units of equipment, representing as it does a variety in age, cost, capacity and scrap account to offset the loss. To make this clear one particular case may be cited.

A certain railway enjoyed prosperity for quite a period of years, at least the holders of two issues of stock were led to so believe, by the dividends actually paid, also promises of increased distribution, melon cutting, etc. In a rather short period of time, the road's apparent prosperity changed to that of adversity, and in a few months it was forced to seek protection of our Federal courts through a receivership.

CLASS DESIGNATION	Light Weight Engine & Tender in Pounds	Book value, aver. normal life in amount to be charged to operating sum of scrap plus depreciation			Total Charge to Operating Expenses for Depreciation	Monthly Charges to Oper. Expenses	Deprec. Charges Plus Scrap Value	Estimated Amount of Betterment Applied & Salvage recovered in percent	Integrity of Company's Capital Account in Percent
		Cost or Ledger Value	Normal Life in Years Depre. 3%	Estimated Scrap Value					
1 Consolidation 2-8-0	230,800	$16,098.77	33	$1,721.25	$14,377.52	$36.30	$16,098.77	3	100
2 Pacific 4-6-2	268,200	16,186.79	33	2,028.75	14,158.24	35.75	16,186.79	3	100
3 Pacific 4-6-2	330,400	41,699.35	33	2,478.00	39,221.35	98.53	41,699.35	3	100
4 Pacific 4-6-2	355,300	61,818.89	33	3,078.60	58,740.29	148.33	61,818.89	3	100
5 Mikado 2-8-2	316,130	26,650.92	33	2,370.97	24,279.95	61.35	26,650.92	3	100
6 Mikado 2-8-2	365,940	67,175.64	33	3,434.80	63,740.84	160.96	67,175.64	3	100
7 Santa Fe 2-10-2	422,800	33,511.04	33	3,056.85	30,454.19	76.89	33,511.04	3	100
			P A S S E N G E R		C O A C H E S				
8 Standard 8 Wh'l	88,072	10,197.98	33	780.00	9,417.98	23.77	10,197.98		100
9 Standard 8 Wh'l	94,200	20,655.55	33	713.00	19,942.55	50.36	20,655.55		100
			F R E I G R T		C A R S	4% Depreciation			
10 Box Car 8 Wh'l	38,600	1,555.17	25-4%	300.00	1,255.17	4.18	1,555.17		100
11 Box Car 8 Wh'l	39,800	2,303.92	25	310.00	1,993.92	6.64	2,303.92		100
12 T.H.B. Gond. 8 Wh'l	41,100	951.40	25	445.00	560.40	1.68	951.40		100
13 D.B. Gond. 8 Wh'l	52,100	2,754.05	25	391.00	2,363.05	7.54	2,754.05		100
14 Hopper Gond. 8 Wh'l	41,000	1,240.79	25	300.00	940.79	3.13	1,240.79		100
15 Refrigerator 8 Wh'l	49,200	1,407.45	25	310.00	1,097.45	3.32	1,407.25		100
16 Refrigerator 8 Wh'l	50,000	3,300.00	25	400.00	2,900.00	9.66	3,300.00		100

NOTE: In all cases the amount charged to depreciation, plus salvage and scrap, must equal purchase price or ledger value, plus betterments and cost to dismantle.

Tabulated Display Showing Class Designation, Weight, Cost or Ledger Value, Average Normal Life, Estimated Scrap Value Total Amount Accrued Depreciation to be Charged to Operating Expenses, Amount per Month, and Depreciation Plus Scrap Value

value, with approximate figures as they would ordinarily work out on one of our large trunk lines. This tabulation should serve to illustrate such points as are referred to, or may arise in the minds of those who may not clearly follow the text.

It will be observed of course that there is a wide range in cost or ledger value, estimated scrap value and the amount to be taken up and charged to operating expenses on units that, in the absence of this explanation, might be considered the same or similar in size and capacity. This is due to the fact that some of these units are only two years old, while others are 10 to 17 years old, and of a widely different character of materials or the specialties and accessories used in their construction. These are all important factors both in first cost, and scrap values, although it must be admitted that no one knows at what price equipment scrap will sell per ton, 10 to 15 years hence.

In a plan such as is suggested by our tabular displays, the shareholders' dollar is absolutely protected against loss of depreciation in value by the fact that the accrued depreciation on each equipment unit is taken up monthly in operating expenses and the scrap value which equals the first cost or ledger value, thus preserving absolutely intact the integrity of the capital account.

Example of Impaired Integrity

What results from acts of omission, if accrued depreciation as shown in the above table is not taken up and charged against earnings? Many striking examples might be cited where the shareholders' dollar has been allowed to depreciate down to practically nothing, without a penny in the treasury or any other

Naturally, the shareholders and others who had been "over fed" as it were on such glowing accounts of their wonderful prosperity and financial strength, were not only badly disappointed, but sought to learn through neutral experts as to the real situation and how it all happened.

The company's material and supply stocks were in bad shape, operation of the line being interfered with in certain instances awaiting for material, while the prodigal expenditures in over or excess stocks of certain kinds, at the same and other points, amounted to more than actually necessary to have had the property in a good state of repair.

No depreciation account had been set up and carried to protect the equipment investment against impairment, and while the loss to freight car property was by far the greater, being many times over that of the locomotives, a review of the latter schedule will best serve to emphasize this point.

Executive and administration officers of the company furnished a schedule of locomotives which on being carefully checked was found to be short three (3) units, and although two of these engines had been scrapped some two and one-half years before, and the third one some twenty-two months before, they were all three still carried on the company's ledger account of assets at the full purchase price or original cost. There was not a penny in the treasury or in any fund of any kind to provide for their replacement, or to conserve the shareholders' money originally invested in them.

After rather dilligent search by the experts employed by the owners of the property, scrap from these three locomotives was located of an estimated value of about two per cent of their original or first cost, which as previously stated, was still carried on the company's books of assets at its full amount, for some two years after the money had been actually dissipated to the vanishing point.

If the shareholders' certificates of stock or evidence of ownership in the physical property of a railway were classified to correspond with the different integral parts embraced in the complete physical operating unit, rather than being purely corporate in character as at present, then the particular shareholder whose money was invested in these locomotives, and against which shares of stock up to their ledger value had been issued would have all at once discovered their stock had no value. The reason being that the physical property back of their shares, the only thing that gave them value, had been dissipated and ceased to exist. There had been no method or plan in effect by the company, whereby the integrity of their investment was protected.

It matters not whether the property investment is in a completed unit, forming an integral part of a transportation system, or whether it be in smaller items of value invested in material and supplies. The principle is the same, and the security holders' loss is just the same on $50,000 worth of lumber, metal, paint, office supplies, miscellaneous stores, etc., as it would be on an equal loss on locomotives, cars or other equipment.

In justice to those who are responsible for the purchase, care and distribution of material and supplies, it is safe to say, that, the purchasing and stores departments as a rule, replenish supply or stock material on hand, on approved requisition of heads of departments and others who are authorized to request its purchase, therefore the fault or blame for unnecessary or excess quantities on hand, and losses to the company on this account, generally speaking, resides with the latter, and not with the former.

As implied in the foot note at bottom of the table, the items of betterment and salvage both are to be considered, and then in the final disposition of locomotives and cars, the question of their sale price when disposed of as second hand equipment for future use must also be held in mind.

The salvage in some instances amounts to as much and in exceptional cases, more than the scrap value of what remains, depending of course on the amount, character and period when betterments were made, but in all cases the amount received for:

(a) The complete unit, as second hand for future use.

(b) Either salvage, scrap or both.

(c) Plus accrued depreciation, taken up in operating expenses.

Must equal in amount:

1: Purchase price, plus betterments applied.

2: Cost to dismantle, or otherwise dispose of.

This phase of the general question of conservation of property or capital accounts, is so clearly related to, and inseparably interwoven with that of material, supplies and idle cash on hand, as to demand the attention of all those charged with its safe keeping.

Mechanical Couplers in India

By Our Foreign Correspondent

Many of those conversant with the delicacies of the standard coupler in use in India will be interested to read of the efforts being made to modify or "improve" it into a "cross-breed" device which will satisfactorily interchange or intercouple with the European system of draw-hook, screw-coupling, and side-buffers, in use there. The difficulties which beset this problem are well-known to coupler experts, and much brain and money have been spent in attempts to find a really satisfactory transition arrangement which will enable a car fitted with A. R. A. type couplers to be easily attached to one having the coupling appliances mentioned. At the Paris Exposition of 1900 several schemes for meeting the case were exhibited; many were tried in service, but eventually, we believe, all were turned down as more or less impracticable. Since that date innumerable suggestions have been made, but so far no real practical and acceptable device has been developed.

In this matter, little benefit accrues from experimental equipment of models which can be easily manipulated with a twist of the finger; only actual operation under service conditions will help the inventor, and any device to prevail must successfully meet these conditions.

Perhaps the most daring attempt in recent times is that which has been undertaken by the Henricot Co., of Belgium. They have boldly tackled the coupler itself, and have re-designed it in such drastic manner that the modification almost amounts to a new coupler only possessing the fundamental detail of a revolving knuckle, common to the standard. The means adopted for clearing the centre of the head, of the locking devices and relocating and housing them at the side, entail such serious re-arrangement of parts that one hesitates to pass any opinion or predict the troubles that may arise.

Those connected with the special work of designing the couplers know full well how a trifling departure of form in one detail from the accepted may adversely affect other details; the A. R. A. coupler, as we see it today, embodies fifty years of experience and thought.

In this new "Henricot" coupler, the knuckle has had a third member, or "tail", added to it. It still retains one at right angles to the knuckle to receive the impact of the operating face of an engaging coupler; this is much reduced in vertical depth, to permit of the third arm being provided at 180 degrees, or in line with the knuckle to pass behind and engage with the locking pin, which falls vertically. This latter is housed in an aperture provided in an additional pocket at the side of the coupler.

The illustration, Fig. I shows the distorted outline of the coupler, head and the position of the locking pin. After the coupler head has been "cleared out," as shown in Fig. 2 it is possible for it to receive a pin from which a link or special screw coupling can be suspended about the centre line of draft—within, perhaps, one inch. The special screw coupling as shown in the illustration Fig. 3. It has a forged block, or nut, so formed that, at the closed extremity, it receives the pin from which it is hung in the coupler. The resultant head is heavy, expensive, and appears to possess many objectionable features in its design, apart from the fact that in service it has been found hopelessly deficient in meeting service conditions, such as vehicles of different draw-bar height. These cannot be successfully negotiated with the knuckle out as shown.

The above describes the most important modification

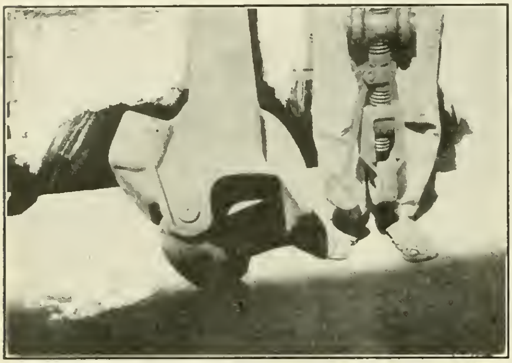


Fig. 1—Altered Head of A. R. A. Coupler. Lock Removed to Side to Enable Screw Coupling to be Hung in Centre

of the standard coupler, proposed by European competitors to date. Others have contented themselves with providing "bollards" or "trunnions" to receive pendant links, etc., or have pivoted the coupler heads vertically or horizontally, to allow the ordinary draw-hook to be available when required.

In the more numerous category of loose and separate transition links, bolts, pins, etc., the drawing, Fig. 4, shows one which has been tried on some of the State

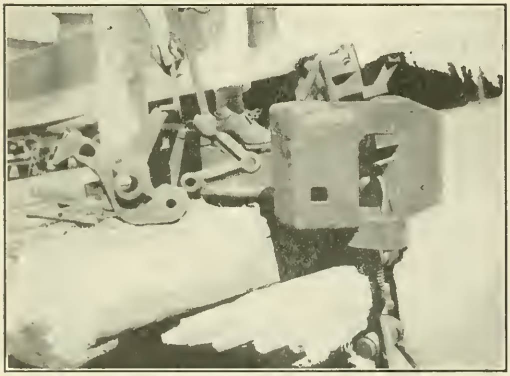


Fig. 2—Coupler Head With Knuckle and Locking Details Adrift. Screw Coupling is Pin Hanging From Centre

Railways' cars. It consists of a "T"-headed casting, suspended from a couple of links, which are portable and carried on the adjacent car to be attached. To function with this arrangement, the end link must first be dropped over the hook of the *unfitted vehicle*, then the T-piece is taken in hand by the operator and held inside the coupler-head of the *fitted car*, whilst the knuckle is closed and locked. The latter has a slot similar to that used in the United States during the transition stage. To uncouple the knuckle of the coupler of the fitted wagon, it can be opened in the ordinary manner, and the T-piece will fall out, to be picked up by trainmen, (if they will) and hung on one side of the vehicle until wanted again. For convenience in handling, hand-holds are provided.

Apart from only a slack connection being secured between two vehicles, there are difficulties of hand manipulation, and the necessity to provide all cars in service with at least one of the special transition devices before a single A. R. A. fitted car can be sent out into interchange. This latter is very serious, seeing that some 120,000 freight cars alone would have to be equipped in prepara-

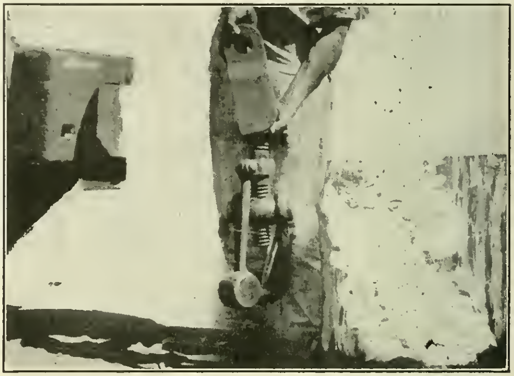


Fig. 3—Modified Screw Coupling Ready to be Mounted in Coupler Head

tion for the change-over; all these additional links to go to scrap as soon as the operation of fitment of the mechanical couplers is complete.

The Japanese Railways have carried through their change in a much more practical manner. They first modified all vehicles as they passed through the shops, to enable A. R. A. couplers to be easily installed. The coupler itself, with draft-gear complete, was then suspended below the under-frame at each end of the wagon ready to be put into its place at the specified time. Then a rapid change-over was undertaken. Trains in transit drew up at prepared depot stations, and a force of some 12,000 trained men proceeded to strip off the side buffers, draw-bars, couplings, etc., and installed the new central mechanical couplers. The operation was completed in one day—a holiday—and approximately 42,000 freight vehicles were dealt with. All the railways of Japan being under one administration, such a procedure as that outlined was possible, and the fact that all the stock on one island was already equipped and could be used to help tide-over any temporary slip in program.

The Indian situation is so different that any effort in the direction of the Japanese method cannot be entertained. There are ten different administrations—five under State control, and five under companies—all, it is true, under the central authority of a Government Department—the Railway Board—but each functioning with a certain amount of independence. Eight of the ten are experimenting with couplers at present. Then there are over 150,000 vehicles to be dealt with, distributed over some 18,000 miles of very widely dispersed track; the staff, too, is very different from the Japanese.

A much more promising solution of the difficulty will probably be found in the adoption of a revised coupler, operating as the A. R. A. does, in the vertical plane, and whilst possessing all the capabilities and advantages of this, will be devoid of many of the shortcomings which the members of the Indian staff as the largest users are cognizant of incorporated in this a facile means of transition or change over can be provided.

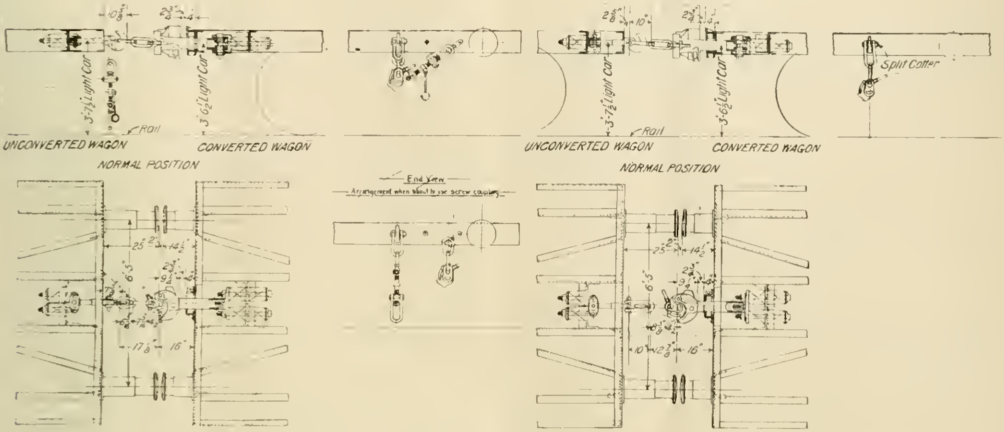


Fig. 4—Arrangement of Devices Used in Transition Fromm Link to Automatic Couplings on State Railways of India

That such a desideratum is possible is made apparent by the fact that some 150 vehicles are at the present time in service on the different railways, equipped with modified vertical plane couplers, introduced by one of the largest manufacturers.

It is not out of place to recall, in this connection the transition period in the United States, from the old link-and-pin coupler, to the present M. C. B. or A. R. A. coupler. It is thirty years ago that the railroads here were in the throes of the changes. Fortunately the problem was not as serious as it is in India. The link was supported in a position approximating that required to enter the coupler on the opposing car and needed only to be lifted slightly in order to slip into place. This could be done directly by hand or by the use of a stick. The latter was the safe method but the former was the common method that resulted in a corresponding loss of fingers and hands by the brakemen.

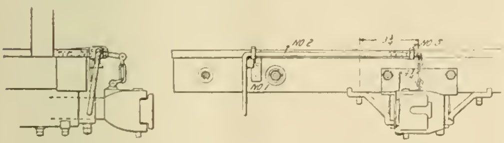


Fig. 5—Showing Slot Cut in Lip of Coupler Knuckle During Transition Period in the United States

When the present standard automatic coupler was adopted a slot was cut in the lip of the knuckle and a vertical hole cored through it as shown in the accompanying illustration, Fig. 5. With this arrangement no extra parts, to be scrapped later were required. If two cars, each equipped with the automatic coupler were brought together, well and good the connection was made as it is now. If two cars were to be coupled, one fitted with the automatic and the other with the link-and-pin couple, the knuckle of the automatic was set in its locked position and the coupling was effected in the same way as with the link-and-pin. The only objection to the arrangement was that the slot and pin hole weakened the knuckle somewhat and made breakage quite common. But, when all cars had been equipped, the slot and pin hole were omitted from new construction and the knuckle assumed the form that it has to-day.

Decrease in Casualties from Train-Service Accidents

Casualties resulting from train and train-service accidents on the steam railways of the United States for the first seven months of this year, as reported by the Bureau of Statistics of the Interstate Commerce Commission, show a decrease of 1,685 compared with the first seven months of last year. There were 359 less passenger casualties and 1,047 less casualties to employees on duty.

Under train accidents are classed those resulting from collisions, derailments, locomotive boiler and other locomotive accidents. Train-service accidents include accidents from coupling or uncoupling trains, operating locomotives, hand brakes and switches; getting on and off locomotives; and accidents at railway crossings, etc. The total number of casualties resulting from these two classes of accidents amounted to 29,140 for the first seven months of this year and 30,825 for the first seven months of last year.

Increased efficiency of railroad maintenance work and the more careful management of trains were responsible for the decrease of 1,736 in the number of train accidents for the first seven months of this year under the same period last year. The total casualties per million locomotive miles decreased from 31.04 in the first seven months of last year to 29.35 in the corresponding period this year. The passenger casualties per one million locomotive miles decreased from 3.07 to 2.70. Casualties to employees on duty, per million man hours, decreased from 28.27 in 1924 to 26.98 in 1925.

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Entered as second-class mater January 15, 1902, at the post office at New York, New York, under the Act of March 3, 1879.

The High Capacity Car

It is a long stride from the standard car capacity of fifty years ago, where tare and load weights were the same and both were fixed at ten tons, to the monster cars of today with their capacities of from one hundred to one hundred and twenty tons, and a tare of from one-third to about one-quarter of the load.

We have been rather disposed to pat ourselves complacently upon the back and point with pride to this great achievement in car construction and wonder as to where we will eventually stop in this capacity growth, with the general idea that there was no upper limit.

There seems to be indications, however, that we have not only reached a desired upper limit but have gone somewhat beyond it for some classes of freight. And one of those classes is coal. Consumers are beginning to complain that coal transported in these exceedingly high or in even moderately high capacity cars, is in such a highly pulverized condition when delivered that it is greatly depreciated in value. We did not think of that when we were raising the sides of our hopper bottom cars to the height of box cars; but, now, that our attention is called to the results it is very easy, with the usual efficiency of hind-sight to see and give a reason therefore.

Coal, like everything else, has a crushing load under which it will break and pulverize. If the load is applied slowly and without jar the depth of the superincumbent burden can be much greater than if there is a constant jar or than if it were to be suddenly applied. Also coal in a bin will arch over, like wheat in an elevator bin, and the whole weight of the coal will not be carried by the bottom, but a large portion, by the side walls due to the friction against them, as developed by that arching. If, however, the bin is subjected to a constant jarring or vibration, the arch will be broken and a greater and greater load be put upon the bottom and the lower strata of the material which it contains.

Now, we know that, owing to the vibration of the springs, the static load on the car bolsters is increased from twenty-five to fifty per cent. and that the imposition of this excess load occurs at an average rate of about three times to the second. It is not strange, then, that with the heavy load the lower portions of the coal are called upon to carry in a deep hopper car, that they should be crushed and reach destination in a depreciated condition.

This experience is not althogether new, for a number of years ago it was found that coal would be pulverized in deep coal bins, that were placed in buildings subjected to vibration by moving machinery. It is not strange, then, that the experience should be repeated and exaggerated in hopper cars with their rapid vibrations of considerable amplitude.

Howbeit, we are beginning to realize this and there appears to be a tendency to limit the capacity of hopper bottomed coal cars to something less than sixty tons. It has been found by calculation and experience that the axle designed for a fifty-ton car would carry one of fifty-seven and one-half tons' capacity with safety and allow for the usual ten per cent. overload. With the result that the trend of popularity seems to be in that direction. Of course the excessive depth could be avoided by the use of a longer car. But there the difficulty of installed unloading apparatus and chute spacing will be encountered, which would make such a solution undesirable.

So possibly, in view of the effect on the loading, we have reached the upper limit of coal carrying car capacities. Probably the experience and practice of the next few years will decide the matter.

Car Coupler Development Abroad

Elsewhere in the pages of this issue will be found a very interesting article from one of our foreign correspondents on "Mechanical Couplers in India." During the past few years we have published in these pages valuable articles from this same correspondent pertaining to different phases of equipment and its development, particularly in the Far East. In the December, 1922, issue of Railway & Locomotive Engineering, his contribution dealt with the proposed introduction of "Mechanical Couplers on the Railways in India." The one in the present issue takes us back to the most interesting, and we may say hectic days, when we in this country were wrestling with the problem of developing an automatic freight car coupler to take the place of the generally used link and pin.

Such of the present generation as had to do with the solution of the numerous phases of the problems then to be solved, no doubt, not only know how we wrestled with them but were also compelled to fight with the promoters of half-baked, untried devices, that we were constantly importuned to adopt and were threatened with all kinds of dire results if we did not acquiesce to their plans. We are, therefore, in position to not only appreciate fully the situation outlined by our correspondent, but to also sympathize with those who are striving to pass through the transition stage he refers to with the least expense consistent with safe operation of train movement and safety to life and limb.

Much credit is due the Japanese railways for the very systematic and successful manner in which they solved the problem, regardless of conditions. The change over from one type of coupling to another on 42,000 cars in a single day is a highly commendable operation.

From 1877 through the years of 1879 there were 90,000 installations of the Safford draw bar (link and pin) on 167 railways in this country. This arrangement had been endorsed by the Association of Yard Masters convention in 1877. These were years of toil, strife and agitation of the coupling arrangement used on cars. In 1882 the late William McConway began manufacture of the Janney vertical plane coupler. Following the master car builders' action in 1888, there were during the years of transition numerous makes or types of couplers. Some were good, some poor, some decidedly bad and some pure freaks. But, out of this whole aggregation we emerged with the present M. C. B. or more correct, A. R. A. standard coupler. When we look at, what appears to us, as the rather crude, expensive, and dangerous device used abroad, we are constrained to ask our friends in the Far East why they did not benefit by our experience, and instead of putting off the evil day by temporizing with an expensive makeshift, why not work out a suitable M. C. B. or A. R. A. type of coupler that is practicable in application and operation?

Emulate the example of our Japanese friends, set apart a day, make the change and thus have the matter not only ended but at once begin to enjoy the full benefits resulting from this improvement.

Railway Equipment

During the early part of the present year there was a disheartening dullness in the railway equipment field that seems to have cleared away, and given place to brighter prospects. Starting in September there was a decided reawakening, and orders have been placed for locomotives, cars, rails and miscellaneous equipment that aggregates between eighty and ninety million dollars.

The orders placed are for nearly 300 locomotives, nearly 12,000 freight cars and over 770,000 tons of rails. All of these involve the purchase of many specialties so that the outlay will filter out into many channels and there will be a wide distribution of the moneys expended. In addition to the items quoted above there has been an extensive inquiry for shop tools and special machinery such as locomotive cranes, steam shovels and the like. With the orders in hand the locomotive works will be kept busy until at least the end of the year. This is an encouraging approach to 1926, and it is to be hoped that the business will not only continue to be good but be free from the spasmodic alternations between feast and famine.

Comfort in the Roundhouse and the Direct Steaming System

To the Editor:

The leading editorial in your September issue states that it seems strange that the example of the city fire engine, wherein a steam pressure was maintained day and night by an attachment to a stationary boiler, has failed to attract the attention of railroad men as a means of lessening the smoke nuisance in the roundhouse by making it possible to do away with fires, and increasing the temperature in winter to the point of comfort by making it possible to close the ventilators and smokejacks.

The lack of efficient stationary boilers, having sufficient capacity and working pressure, together with an ample roundhouse steam main, properly lagged, is one reason why railroad men have not adopted the practice of holding locomotives under steam by connection to a stationary boiler. There is no mechanical facility of which the railways are generally in greater need of today than efficient stationary boilers of sufficient capacity. Another reason why this practice has not been developed is the frequent water change and boiler washouts necessitating the release of all steam from the boiler and refilling with water considerably below steam temperature.

The Direct Steaming System to which your editorial refers, requires adequate stationary boilers and provides direct connections to locomotive boilers at each stall so that it may be utilized for the purpose of holding locomotives under steam in the manner above referred to. There is no novelty in this other than the improved stationary boiler equipment required, but the Direct Steaming System can also be utilized for filling locomotive boilers and generating a working steam pressure in locomotive boilers with a fire on the grates.

With the Direct Steam System, the locomotive is first filled with a mixture of live steam and hot water that enters the boiler at a temperature above 212 degrees F. until the desired water level is reached. The hot water valve is then closed and the flow of live steam continued until a working pressure is established in the boiler. In this respect, the Direct Steaming System represents a development over the old practice of holding fire engines under steam which only required a live steam connection to the boiler and made no provision for injecting mixtures of live steam and hot water for the purpose of steaming up the boiler.

The method of first filling with a mixture of steam and hot water at a temperature above 212 degrees F. is essential to subsequently establishing a working pressure in the boiler by the continued injection of live steam for the simple reason that if the preliminary filling temperature is below 212 degrees F. the subsequent inflow of steam will merely condense and build up the water level in place of building up a working steam pressure with corresponding water temperature throughout the boiler.

The Direct Steaming System not only provides a means for steaming up locomotives without a fire on the grates, but accomplishes a considerable reduction in the time required to fill and steam up a locomotive. Furthermore, the Direct Steaming System tends to equalize the temperatures rise throughout a boiler as it is filled for the reason that with the filling temperatures above 212 degrees F. some steam is liberated within the boiler as it starts to fill and condenses upon the upper shell of the boiler so that the upper portion of the boiler shell expands evenly with the lower portion which is covered with hot filling water.

Where the ordinary hot filling water method is employed without the introduction of steam, the lower shell of the boiler becomes relatively hotter than the upper portion during the filling up stage; while, with cold water the lower shell is relatively colder so that in either case the unequal expansion of the shell places the boiler under a strain. Another aspect of the Direct Steaming System is that water temperatures throughout the boiler correspond more nearly to the steam temperature when steamed up in this manner than when steamed up entirely by means of a fire on the grates, in which case the water temperatures surrounding the firebox are considerably higher than in the forward end of the boiler owing to inadequate circulation.

It is not true therefore, that the Direct Steaming System is essentially an old method, as might be inferred from the editorial above referred to, in which you imply that the practice described in my recent paper before the Smoke Prevention Association differs from earlier practice only in the details of appliances used for its application.

Furthermore, you have placed your readers as well as the writer, at some disadvantage in commenting upon the proceedings of the Smoke Prevention Association, without publishing at least an abstract of that portion of the proceedings to which you have referred so generously in your editorial.

The emphasis which your editorial places upon the direct gain from improved efficiency due to better working conditions at the locomotive terminal is commendable although the writer cannot fairly be accused of being "strangely silent" on this feature of the Direct Steaming System, in view of the following paragraph from his report before the Smoke Prevention Association:

"Where the enginehouse is designed for fireless operation, no smoke jacks are required and an effective arrangement of overhead lighting and ventilation may be employed. This, combined with the entire elimination of smoke and noise of escaping blower steam makes it possible to duplicate back shop working conditions in the enginehouse. This will have an obviously beneficial effect on the character and cost of locomotive maintenance at the terminal since the dingy and noisy conditions commonly found in enginehouses today are undoubtedly responsible for much faulty and negligent attention to the current maintenance of locomotives."

L. G. Plant.

Treated Water Increases Locomotive Efficiency*

By R. C. Bardwell, Superintendent of Water Supply Chesapeake & Ohio Railroad

The quality of water supply is connected closely with the operating efficiency of a railroad; its effect is of vital interest to the management, as well as all departments. Of the 350 billion gallons of water used annually for steam consumption on American railroads, it is estimated that 50 billion gallons or about 15 per cent, are receiving treatment in some form, at an average cost of four cents a 1,000 gallons for treatment, the yearly expense involved is about $2,500,000.

There are approximately 1,200 water stations in a total of 16,000 where chemicals are added. The total investment in softening plants, including the inexpensive as well as the complete type, is at least $10,000,000. It is estimated these plants are removing annually 100,000,000 pounds of scale forming solids which, if allowed to enter the locomotive boilers would represent an additional expense in locomotive operation and maintenance of approximately $13,000,000.

Quality

A recent publication of the United States geological survey, classifying 307 water supplies from the principal cities of the United States, indicates that 234 were received from surface waters, and 73 from wells. This ratio will hold true probably in railroad service.

Both the quality and quantity of water in streams, ponds and small lakes, is subject to seasonal fluctuation. During wet or stormy periods the heavy mud and sediment carried indicate, from visual inspection the need for improvement. During the dry season and low water stages the water may clear, but the influence of the dissolved minerals is much more severe. As a rule, well waters are clear, but frequently are hard. This is not objectionable for drinking purposes but requires treatment for economical use in locomotive boilers.

The question of quality is more or less complex. When water comes down as rain, it is fairly pure. It saturates the ground and absorbs minerals. In some soils it absorbs these minerals faster than in others. The soil will take up only so much water and the remainder runs down into the creeks. During dry seasons, such as were experienced universally throughout the country during the past summer, there is little pure rain water in the streams; what water is available is largely that which has soaked through the ground and dissolved the various minerals.

There are two general classes of minerals which water picks up: First those which cause scale and pitting, including solids; the other is the alkali salts, such as common table salt. It must be understood the minerals referred to are those in solution which cannot be seen and do not settle out. The mud and sediment occasionally washed down into the creeks, is a temporary condition only and settles gradually. The soluble minerals remain in the water until forced out by chemical action. When soluble minerals are present it is necessary to make a chemical test to determine the amounts of damage they will cause, but the mud and sediment can be seen without testing.

When water is taken into the boiler, steam, which is pure water in the form of gas is generated. The pure water goes off through the exhaust and the mineral content is left behind. At high boiler temperatures the scaling solids are not soluble, but crystallize as a hard coating on the tubes and sheets. If acid is present the heat helps it to act rapidly on the tubes and sheets and start pitting. The alkali salts do not cause scale or pitting necessarily. They are very soluble and accumulate as sludge until water gets sticky and has to be blown out.

Taken as a typical example water containing 21 grains of dissolved solids; this means three pounds of solids in 1,000 gallons. A consolidation type locomotive boiler will hold approximately 3,000 gallons. When the boiler is first filled, the water contains nine pounds of solids. As the water evaporates these solids are left behind, and for each 1,000 gallons additional three pounds more are accumulated. Such an engine will use about 15,000 gallons on a trip which means that 45 pounds of these solids are deposited in the boiler. If pure water was used and 45 pounds of dry chemicals dumped into the engine tank on each trip, it would look bad, but the results are the same.

Scale

Scale forming salts are divided into two general classes. The most important, and the type which causes the most damage, is the sulphate or "gyp" scale. These are minerals soluble at ordinary temperatures but which reach their saturation point early at the high boiler temperatures, and crystallize out as a hard, flint like scale. The "lime" or carbonate scales frequently present in large amounts are of the softer variety. If the sulphate scale is absent or eliminated so the hard binder effect is removed, the lime scales do not cause serious damage to the equipment. They do, however, clog up the water space gradually, or make the water dirty. This sometimes results in a "mud burn" which requires, for prevention, frequent washing or blowing down.

Pitting and Foaming

The most common form of boiler pitting results from

*A paper read before the convention of the American Railway Bridge and Building Association.

the presence of sulphuric acid in the water, due to pollution by coal mine drainage. The sulphur present in coal seams oxidizes, frequently to the point where sulphuric acid in quantity is formed. The action of this acid on iron and steel is well known. Another form of pitting is due to mechanical defects such as sheets with non-uniform tension, matched improperly. Again it may result from using materials which have been cared for improperly, such as steel which has been permitted to lie out in the weather without protection, on which atmospheric corrosion has already started. In the western sections of the country where it is necessary to use waters containing large amounts of alkali salts, serious pitting has been experienced from the increased electrolytic conductivity or action of such waters.

Boiler foaming is one of the most aggravating problems in railroad water supply. This results from a condition of the water surface in the boiler which prevents the steam bubble from breaking free. When the bubbles build up to the throttle opening, water is carried over with the steam. The situation is analogous to the boiling over of a coffee pot. Locomotive cylinders are designed to operate by steam pressure and their efficiency is destroyed immediately by the presence of water.

Foaming is caused by a combination of two things: First, heavy accumulation of the soluble alkali salts; second, the presence of mud and other matter in suspension, such as loosened scale. The situation can be controlled largely by conditioning and clearing the water properly before it is given to the locomotives, by regulating washouts or water changes, or by occasional use of the blowoff cocks. The last two actions remove the suspended matter and reduce the alkali salt concentration. Where foaming exists it is an indication that the situation is not being handled properly.

Water treatment probably is as old as steam boilers. It has developed from the primitive stage of adding some material directly into the boiler, to the present refinement of complete softening and final filtration before the clear, safe water is given to the locomotives.

Boiler Compounds

The oldest, best advertised form of water treatment probably is the addition of boiler compound or chemicals, such as soda ash, directly into the locomotive boiler or tank. This process has been improved since it was used first, and in those cases where the material is added, either in the boiler through washout holes or in the engine tanks, or in some cases in roadside tank or pump discharge in solidified form which dissolves slowly, good results on waters of moderate hardness have been secured. The disadvantage of the system is its lack of dependable checking, regularity, and properly proportioning the treatment.

Soda Ash Treatment

From a first cost standpoint, the addition of the soda ash to the water in roadside tanks to soften all the sulphate, or hard scale forming water, is the least expensive form of systematic treatment. This system is used extensively on some roads. With close supervision and close systematic checking it can be made to give satisfactory results. Where the concentration in the boiler is not maintained within working limits by frequent blowing down, this system has the disadvantage of producing acute foaming conditions with consequent interference to train movements.

There are several means used to proportion properly the soda ash to the sulphate, or hard scale, content in the raw matter. At places where the consumption and treatment is light, results may be secured by hanging a burlap bag, holding the 24-hour requirement of soda ash from the rafters of the roadside tank. Another scheme is to place a small box at the top of the tank and spray a part of the water discharge on a 24-hour charge of soda ash contained in the box. Where larger amounts are required, various proportioning schemes are in service. One of the most popular is a divided drum with a flexible diaphragm partition. In this method the dissolved soda ash on one side of the partition is forced into the tank approximately in the ratio of the water pressure on the opposite side of the diaphragm by a small inlet of raw water taken from the back of a partly closed valve on the pump discharge line. Water motors and small steam pumps also are used sometimes. The success of any such system lies entirely in close supervision and check, to assure neither too little nor too much soda ash being used. It is necessary also to follow the locomotive boiler operation in order that the boiler concentration may be held within workable limits to prevent loss and delay from foaming.

Zeolite

Some experiments with zeolite are under way at present. This system provides that the raw water be run through a filtering medium which has an interchangeable base. That is, the filter replaces the scale forming elements with non-scale forming alkali salts. At specified intervals the filter is regenerated by soaking in a strong solution of common salt. Experience in this section has shown this system to give ideal service for laundries and similar industries, but the excessive alkalinity produced results in foaming, and the high cost for prefiltration and salt regeneration, have retarded its use for steam boiler service.

Lime-Soda Plant

The standard method of complete water softening requires predetermined amounts of lime and soda ash to be added to the water at wayside settling tanks. Its object not only is to soften the water, but to remove the precipitated sludge with other suspended matter, so as to deliver the soft, clear water to the boilers. Common lime and soda ash are used, because they are the lowest priced chemicals which can be obtained to do the work efficiently and satisfactorily. The types of the plants vary with the patented proportioning equipment on the market, and with the designs prepared to handle best the local and individual conditions. Experience has shown that, with proper attention and supervision, satisfactory results can be secured in the matter of eliminating scale and pitting. Usually, the economies effected far exceed the estimate.

There are two general types of lime and soda ash plants—the intermittent, and the continuous. The intermittent type consists of one or more tanks filled with water to which chemicals are added and the mixture stirred. After a period of sedimentation the water is clear and ready for use. At points where an additional roadside tank can be erected and agitation produced by means of perforated air pipes, this makes an adaptable installation. The old and new tank can be used alternately for delivery to locomotives by manipulating of valves. Such a system will soften the water and give the station the advantage of duplicate tank facilities.

Other intermittent systems have the treating and settling tanks at ground level, and pump the clear, softened water to elevated tanks for delivery to locomotives. Such plants vary in treating capacity from 10,000 gallons to 500,000 gallons, but the governing principle is the same, and similar satisfactory results can be secured.

Continuous Systems

Plants of the continuous type consist of large tanks, usually of steel, with inside tubes of sufficient size to retain the water 30 to 45 minutes, while mixing. The water and chemicals are mixed in these tubes in continuous proportion. The water flows from the mixing tube to the bottom of the sedimentation tank from which it rises to a predetermined point before the clear water is drawn off for service. The specific gravity of the precipitated sludge is high enough to give complete clarification in five hours if the upward velocity of the treated water does not exceed six feet an hour.

If clarification troubles are experienced, filters are used sometimes. Matted excelsior is placed at the top of the settling tank, although there are plants having rapid sand or pressure filters. Either of the latter requires transfer pumps which are unnecessary where matted excelsior is employed.

Experiments are under way to eliminate the down take tube and merely run the chemicals and water together without special mixing or agitation at the bottom of the sedimentation tank. Experience with this system some years ago was not altogether satisfactory. Types of sedimentation tanks vary. Some have a preference for cone bottoms, while the flat bottom tanks with sludge systems meet with favor in other localities. A complete discussion of the relative merits is not possible in a general paper of this type.

There are a number of ingenious proportioning devices on the market. Some consist of flow control and constant feed; some have wier or orifice proportioning with variable feed; others have a tipping bucket and constant head orifice control; still others have a water motor dependent upon comparative cylinder displacement ratio. Any of these types can be made to give satisfactory results with proper supervision and a good check and follow-up system.

It seems needless to say that any of the various impurities in water will cause trouble, contingent upon the amount of type. Removal of such impurities is certain to show improved results, depending on the amount removed. The American Railway Engineering Association presented figures in 1914 to show the cost of each pound of incrusting matter entering the locomotive boiler was seven cents. This was based only on the effect on fuel consumption, boiler and roundhouse repairs and engine time for same. Transposed to present day prices, this figure is 13 cents. Study for the past four years by a special committee of the American Railway Engineering Association, based on statistics which have been gathered, indicate this figure is conservative. With proper treatment of the water, scale and pitting conditions, with their incidental boiler maintenance expense, can be eliminated very largely. Fuel consumption in clean, tight boilers is less than those leaky or sadly scaled. The large intangible benefits, such as elimination of engine failures on the road, and the reduction in delays to traffic and train movement, exceed usually the tangible savings in fuel consumption and boiler repairs. The savings which can be made depend largely upon the trouble caused by the natural adverse conditions, and is measurable by the amount of impurities present. However, each individual situation is a problem in itself and requires special study to secure best results.

Oil-Electric Switching Locomotive of 100 Tons Weight Developed for Long Island Railroad

The Long Island Railroad is obtaining for switching service in its Bushwick Terminal, Brooklyn, an oil-electric locomotive of 100 tons weight. A similar locomotive of 60 tons weight was introduced by the General Electric, Ingersoll-Rand and American Locomotive Companies, and demonstrated on various eastern railroads. This was described in detail in the September, 1925, issue of this publication.

The locomotive for the Long Island Railroad will differ not only in being larger, but also in having two oil-engine driven generator sets to furnish the power to the four direct current, geared traction motors.

The 100-ton locomotive has a steel, box-type cab with platform carried on two four-wheel swivel trucks.

The cab is of ⅛-inch blue annealed steel, riveted to a framework of steel angles and channels. It is divided into three compartments, the central compartment containing the power plant and control apparatus. The two end compartments are reserved for the operator. Doors are located so as to give access to each operator's compartment from the outside and to the central compartment from the operator's compartments. A hatch is provided in the roof of the central compartment directly above the oil engines to permit their removal. A smaller hatch in the main hatch facilitates inspection.

Engine Equipment

The oil engines, manufactured by the Ingersoll-Rand Company, are six cylinder, vertical units of the four cycle type, with pistons of 10-inch diameter and 12-inch stroke. Each develops 300 horsepower at 600 r.p.m. With suitable oil, fuel consumption does not exceed .43 pounds per engine b.h.p. at rated load and speed. This figure is based on oil containing 19,000 B.T.U. per pound.

Each engine is equipped with a self-contained, complete lubricating oil system, with direct attached circulating pump. A water circulating pump is direct connected to each engine for circulating cooling water to cylinders and heads, and an air compressor is direct connected to each engine to automatically keep the starting air bottles charged.

Electrical Equipment

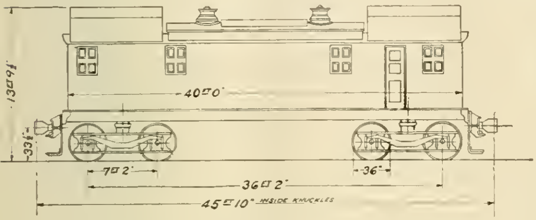
Direct connected to each oil-engine is a six pole, 600 r.p.m. direct current, compound wound, commuting pole, General Electric generator. A 4 pole, 60 volt generator is mounted on the same shaft as each main generator, and serves to excite the field windings of the main generators. A 32-volt storage battery is supplied for the exciter fields at low speeds. The main generators are differently compounded so that the voltage is approximately inversely proportional to the tractive effort.

There are four direct current, series motors of the single geared, box frame, railway type, classified as GE-69-C. Each motor is supported on its axle by axle brackets and bearings, and by the motor nose on the truck transom. The gearing is selected to give maximum allowable locomotive speeds of 30 m.p.h.

Control and Auxiliary Equipment

One of the distinctive features of the locomotive is its control system. This is the automatic control which has been used on a number of equipments furnished by the General Electric Company for self-propelled cars and locomotives. With the differential winding of the generator the output in amperes and volts automatically adjusts itself to meet the requirements of the service and the power delivered by the engine. The only operating handle is the throttle handle that controls the output of the engine. An electric switch handle determines the connection of the motors in series or in parallel and for forward or reverse movement. No rheostats are used and the loss of power in the electric circuits is reduced to a minimum.

After the series parallel switch has been set for either forward or backward movement, the throttle handle determines the power delivered by the engine. The



100-Ton Oil-Electric Switching Locomotive

generators and motors transmit that power to the driving wheels automatically adjusting the proportion of tractive effort and speed to the load on the locomotive and automatically changing these proportions to suit the varying requirements of acceleration or grade.

Means are provided for starting and stopping the engine from both operating positions. Non inductive motor field shunts give higher running speeds at light loads.

Auxiliary equipment includes a gasoline-engine driven air compressor; three high pressure air storage tanks to be used for starting the oil-engines; a water heater and expansion chamber to keep the cooling water from freezing when the engines are not operating and for heating the operator's compartments; four fin type radiators of 2,400 square feet total surface on the roof for cooling water from the engine; exhaust pipes and mufflers on each oil engine; and water tanks in the cab into which the water may be drained in the winter when the locomotive is idle.

A 60-ton switching locomotive to be supplied to the Central Railroad of New Jersey is similar to the 100-ton engine of the Long Island Railroad, described above, except that one 300-horsepower oil engine, one generator, and four type HM-840-G motors are used.

Some details of the 100-ton oil electric locomotive are as follows:

General Specifications	100-ton	60-ton
Length inside knuckles	45 ft. 10 in.	32 ft. 6 in.
Length over cab	40 ft. 0 in.	28 ft. 0 in.
Height over radiator	13 ft. 9½ in.	13 ft. 9½ in.
Width overall	10 ft. 0 in.	10 ft. 0 in.
Width of cab	9 ft. 4 in.	9 ft. 4 in.
Total wheel base	36 ft. 2 in.	24 ft. 2 in.
Rigid wheel base	7 ft. 2 in.	7 ft. 2 in.
Track gage	4 ft. 8½ in.	4 ft. 8½ in.
Minimum radius of curve (alone)	90 ft.	90 ft.
Total weight (all on drivers)	200,000 lbs.	120,000 lbs.
Weight per driving axle	50,000 lbs.	30,000 lbs.

Crown Sheet Failures

Crown sheet failures are usually regarded as a man failure, though it is probable that this was formerly frequently unjust. Low water is the almost invariable cause; but the investigations of Mr. Pack as to the reliability of the water level indicators as they were applied, has taken the burden of the responsibility for the earlier failures from the shoulders of the engineer and placed it upon the faulty application of the apparatus.

And, proper inspection and repair of all parts and appliances of the locomotive are essential if accident, injury and delay to traffic are to be avoided.

The accompanying table shows the total number of crown sheet failures that have occurred from the fiscal year ending June 30, 1912, to March 31, 1925.

It would appear from this table that the supervisory inspection of the Bureau of Safety had an important influence on the decrease of crown sheet failures; but that even its inspection and supervision was helpless in the face of the incompetency of government control.

Starting out with the peak record of 92 failures, in connection with which 50 men were killed and 167 injured, the number rapidly decreased until 1915 when the record for minimum in failures and casualties was attained. Then, with the war, they increased rapidly until, in 1918, in the peak of government control, the number of failures had risen to nearly the peak record of 1912.

Since then the number has steadily fallen except for the sudden jump in 1923. This decline has continued until the present when it has almost touched the low record of 1916, with the prospect that in the current year it may even drop below those figures.

The number of locomotives inspected annually has

Year	Locomotives Inspected	Total Crown Sheet Failures		
		Accidents	Killed	Injured
1912	62,074	92	50	167
1913	63,870	72	29	117
1914	65,340	48	16	77
1915	67,490	23	8	34
1916	66,781	39	20	59
1917	67,239	61	45	98
1918	67,514	85	32	143
1919	69,499	65	39	109
1920	69,910	59	41	81
1921	70,475	53	43	78
1922	70,070	27	61	49
1923	70,242	53	39	83
1924	70,683	42	45	56
1925*		18	6	32

* First nine months
(July 1, 1924 to March 31, 1925)

Crown Sheet Failures and Casualties From 1912 to 1925

risen steadily, with but two breaks throughout all of these thirteen years, though that increase has been but slight, the total figure being very close to the total number of locomotives in the country, which means, of course, that every year a certain number of individual locomotives have been inspected more than once.

Classifying Repairs of Freight Equipment

A Paper Read at the Annual Convention of Chief Interchange Car Inspectors and Foremen's Association

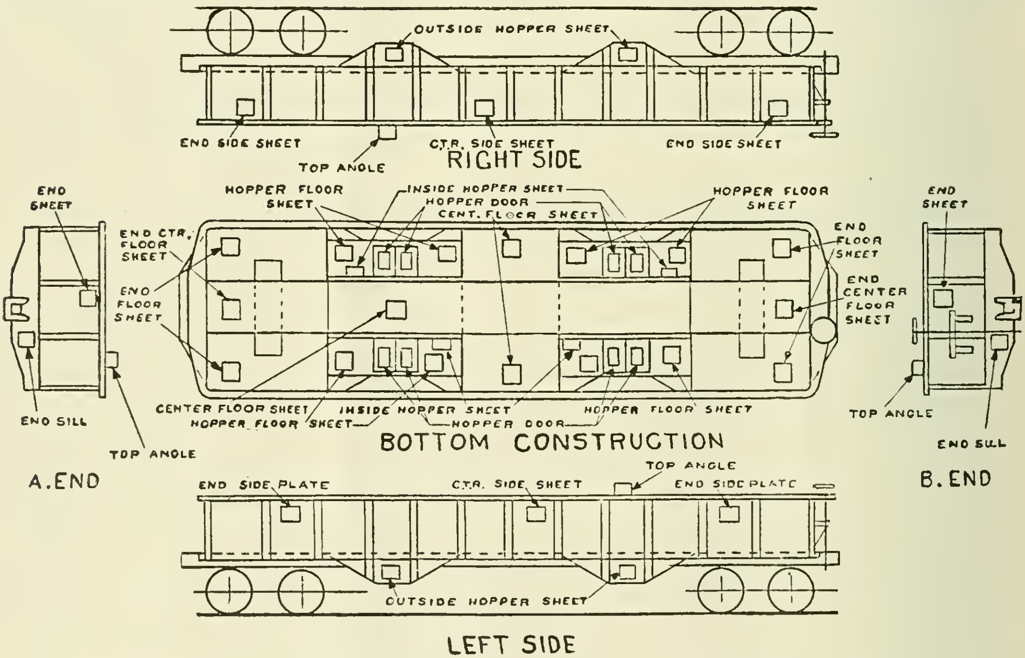
By F. A. Starr, Gen. Car Inspector Chesapeake & Ohio Railroad

Many forms of scheduling and routing have been developed and successfully installed in locomotive and passenger car repair shops. Only in the last few years has any degree of success been reached in the scheduling of freight cars. Fundamentally, the systems are similar in principle and application, and there is no reason for assuming that a system which has greatly benefited locomotive and passenger car repairs will not produce satisfactory results in freight car repairs.

The great number of freight cars automatically induces systematic shop methods, but scheduling and routing freight cars through a shop is more difficult on account of the many types of cars and the extensive area over which they are used as compared with either locomotive or passenger cars. The most successful freight car scheduling is dependent upon large operation, and the number of cars in a series, sufficient material and supplies and a complete organization which will enable men to be highly classified into special gangs. It is not difficult to handle scheduling and routing methods in freight car repair shops, but it may be necessary to rearrange or relocate repair tracks completely, material, storage and associated shop facilities.

It has been demonstated that with the progressive system greater economies can be effected than with any other method yet devised. This system permits of organizing properly shop forces, systematic delivery of material at designated points and at defined intervals. It is conducive to specialization of the work by groups and individuals. It lessens the number of tools and equipment. It simplifies supervision, as the men become familiar with and more efficient in the execution of the particular operations for which they are responsible. They are induced to devise plans and means, and to provide themselves with suitable tools adapted to their portion of the work which will contribute to increase and improve the output, and reduce labor costs.

The only objection to the adoption of this system is the effort necessary to collect cars of the same series, at the same shop in sufficient number to make the operation a success. The work on another series of cars might retard the production. It is, however, possible to overcome this difficulty if a schedule of classified repairs is arranged to extend over a period of from two to ten years. In such a program cars in certain series can be shipped to the shop to which particular series have been allotted. The practicability of shopping cars by series or classes is recognized. Many difficulties have been overcome to the extent that the method has become quite general in its application to heavy and classified freight car repairs.



Form of Report of New Steel Parts Applied to Steel Cars on Chesapeake & Ohio Railway When Given Class 4 or 5 Repairs

Proper shop facilities and tool equipment are essential for successful and economical operation of any production plan. Punches, shears, presses, furnaces, cranes, tractors or electrical trucks, and a sufficient supply of pneumatic tools are indispensable in a modern car shop. For repairs of steel cars, electric power generators and equipment for burning rivets, straightening frames, oil or gas heaters, and acetylene cutting and welding apparatus are some of the more essential machines. Wood working machinery, which eliminates all possible work by hand is another important item in repairing wooden cars.

Proper facilities should be provided to handle all scrap parts that accumulate. Shop premises should be kept clean at all times. This may not seem important, but it has a moral effect on the workmen which should not be overestimated, and will contribute greatly in lowering the hazard of personal injuries. Other facilities such as storehouse, paint shop, air brake shop, oil house, and good pavements should be provided and placed as near as possible to the repair tracks. Tractor service for quick and economical transportation of material should be introduced.

Sufficient intelligent supervision must be given or the quantity and quality of the output will suffer. The gang foreman who comes in daily contact with every man under him, is the most important factor in the organization. He forms the contract between the management and the men, and if this contact is broken, efficiency suffers. While a thorough knowledge of how to perform the work is necessary, the ability to handle men is the first requisite, and stands above any other qualification.

The foremen should be intelligent and fairly well educated, so that they may be able to read the rules, blueprints and instructions, and apply them correctly. They should be eligible for promotion to positions of greater responsibilities, and their salaries should be sufficiently attractive to create an incentive to fit themselves for higher positions. Workmen are quick to detect indifference on the part of those above them, and an unfavorable attitude resulting in discernment often produces a powerful influence against the efficiency of the organization as a whole. No man can be a success in anything without putting into it something of himself.

An important item is the prompt delivery of material. This should be done by tractors or electrically driven trucks with trailers, unless the shop is equipped with overhead cranes. No work should be started on a repair schedule until all material necessary to complete the work is on hand in sufficient quantities to carry on the work until the remainder required can be procured. There should be no hold-up in production on account of shortage of material.

The purchasing of material has its individual problems. Close co-operation with the local and general offices of the stores and purchasing departments in the ordering and the handling of material under centralized control is essential.

In actual repairs work it is suggested that draft gears, attachments and center sill constructions be strengthened sufficiently so that shocks incident to modern service will be absorbed and distributed throughout the car without causing excessive damage to the superstructure. A common cause of failure in steel cars is due to the bodies of hopper cars not being securely fastened to the center sills. A few rivets are driven in the hopper sheets to hold the body to the center sills. The rivet heads corrode or wear off, allowing the rivets to pull through the sheets This results in the whole strain being thrown on the body bolsters which can not stand up under the load. The sills are moving back and forth under the car body which soon gets in such a condition that permanent or thorough repairs become a rather expensive operation. These conditions must be overcome as far as possible when a car receives heavy repairs.

The sides and ends of steel equipment should be properly reinforced to prevent bulging or buckling. Doors and door equipment and appliances should be kept in proper working order to facilitate unloading. Care should be taken in repairing trucks on all cars to provide proper side bearing clearance and to see that air brakes and running gears are kept in good condition.

A well defined program of reinforcement should be outlined and put into practice on all roads. The cost of such additions and betterments usually is insignificant when the further life and productive service of the car is considered. Money appropriated for such features is a good sound investment when judiciously used and should pay large dividends. Many roads make the mistake of not repairing old equipment in time. Poor equipment should be either reinforced or kept on home line, and not be offered in interchange. There is the possibility of its getting into large industrial centers and into heavy tonnage trains, and it is almost impossible to keep it off the repair tracks. An unnecessary burden of expense is thus placed on both the owner and the handling line.

As cars go into the shop for general repairs, a careful inspection should be made. If a car has deteriorated it should be repaired in accordance with a well defined reenforcement program. If this is not done, it will soon again come back to the repair track.

Classified Repairs on the Chesapeake & Ohio

Three or four months before the close of a year, a general meeting of district and divisional car department officers is called, and a shopping schedule is discussed thoroughly. A chart which has been prepared previously, showing cars due for classified repairs or rebuilding during the coming year is carefully considered, and cars allotted to individual shops. Cars in one series are seldom allowed to go to one shop but to at least two shops at opposite ends of the road. All cars which must be rebuilt are selected by their general condition. The age is an important factor in determining just what parts of the cars must be renewed.

Past experience, tests and service conditions, and requirements under which steel equipment is used, have shown that floor and hopper sheets should be renewed after 10 or 12 years, while the side and end sheets will run for approximately 16 years, if ¼-in. thick. A definite program of reinforcement is outlined and closely followed.

At least 90 days is allowed before any repair work is started. This enables the purchasing and stores departments to procure and deliver necessary materials. Immediately following the allotment of cars to be rebuilt every shop participating in the repair schedule places a requisition for 50 per cent of the material it requires. This material should be placed on the ground in time promptly before the work is started. The other 50 per cent is requisitioned so that it will be delivered in time to prevent any cessation of the work.

If more than one series of cars is allotted to one shop, the order in which the series is to be routed through the shop is determined at the general meeting. Material is ordered accordingly, and the same advance information is given to the stores department as mentioned previously.

The entire program is laid down on a schedule or performance sheet which permits the recording of all performances, starting and completion dates in proper sequence. A close co-operation between the car and stores departments is absolutely necessary, not only to prevent shortage of material but also to avoid surplus material being left on hand, when the program is finished.

Classified Repairs of Steel Cars

Cars in same series are placed on bonded tracks and inspected by a competent inspector or gang foreman. All sheets which must be removed and replaced are marked with yellow crayon. All sheets and other parts which must be removed, repaired and replaced are marked with red crayon. All rivets, not in sheets and other parts marked for removal, which must be burned off, are also marked by the inspector.

All scrap steel is picked up daily by a locomotive magnet crane and loaded directly into cars on scrap sales order previously obtained by the purchasing department. This method eliminates unnecessary handling and necessity of providing storage space to accumulate the scrap while awaiting sale. Parts to be repaired are replaced and pooled at the straightening shop. This shop is equipped with furnace, face plate, presses and necessary tools to restore parts to their original shape. The dismanteling of the car constitutes the first operation, and the skeleton of the car is moved to the heavy repair tracks.

The second operation is performed by the truck gang. The cars are jacked up and placed on tripods; the trucks are dismantled, and all broken or defective parts removed. This gang repairs all trucks and placed the cars on the trucks at the proper stage in the schedule. All arch bars are removed and taken to the blacksmith shop where they are annealed and reset. Cracks and fractures are easily detected by this process.

In the following operation couplers, draft gears, cylinders, reservoirs, bolsters, tie plates, space blocks, center plates, draft gear castings, and other parts to be removed from the car are dropped. Following the dismantling, gang 4, or the straightening gang, straightens all parts that are marked to remain on the car. In this operation the car is prepared for the fitters.

The first fitters, constituting gang 5, follow and fit up all underframe parts including end sills, tie plates, splice plates, space blocks, corner posts, side sills and center plates. Gang 6 is the first reaming gang. The underframe is reamed and made ready for the first riveters. The first riveters in gang 7 drive all rivets under the car body and all additional rivets which must be driven before the car is fitted with side and floor sheets. Gang 8 is designated as the bench gang. When entire sides are renewed, the side sheets, stakes, top and bottom angles are assembled on the bench in jigs. The complete side is applied by means of a locomotive crane by the ninth or second fitting gang. Gang 10 removes the entire body and prepares the car for the riveting gang.

The body riveters in gang 11 drive all rivets in the body of the car, in grab irons, sill steps, brake shafts, platform brackets and door attachments. One gang fits up all door locks for final riveting. Gang 12, the coupler gang, works at any time after the bottom of the car has been riveted. This gang applies all couplers, uncoupling levers, card holders, brake mast, brake rods and levers, center pins, and greases center plates and side bearings. It places the car on the trucks and gauges couplers and adjusts side bearing clearances. In the following position, riveters drive all rivets in door locks, front carrier irons, and any rivets overlooked by the regular riveters in previous positions.

Laborers and helpers form a material delivery gang with two or more men for every electric truck. They handle all couplers, arch bars, truck side frames and similar material to and from the blacksmith shop. One man keeps the rivet heating furnaces in good condition and looks after the oil supply for the furnaces and heating torches.

Material racks with bins are placed conveniently to the shop tracks, in which are kept bolts, nuts, washers, cotters, clevices, knuckle pins, nut locks and similar material, used in small quantities. One man is in charge of these racks, replenishing the stock daily. He picks up usable material left on the ground by the car men, returning it to the proper bins in the nearest rack. A standard list of material carried in each rack is posted. Every forenoon the attendant makes a check of the material on hand. Any shortage is ordered at one time and replaced in proper bins.

Cars ready to be painted are moved to the shipping track where air brake men, two car repairers and one apprentice apply brake cylinders, reservoirs and other air brake parts. All parts are cleaned and repaired in accordance with the A.R.A. rules governing the maintenance of brake, train and air signal equipment.

The cars are painted on the shipping track with paint spray. The painters work from push cars running on service tracks. When the paint is dry, the stenciling is done from scaffolds erected on a push car on which all supplies and stencils are carried. The painter moves himself on this push car by taking hold of the side of the car, pulling the scaffold and pushing the car with him to desired location.

A final inspection is made of the cars on the shipping track. Any work marked by the inspector is corrected if possible before the paint gang has left the car. Cars are then reported ready to be pulled and weighed. An individual car record of all sheets removed is kept on special forms as shown in the accompanying illustration. These forms are filed numerically. A record is available at all times in the general office, so that the general condition of the individual car or series can be determined.

Classified Repairs to Box Cars

After cars of one series have been spotted and properly spaced, a careful inspection is made by a gang foreman accompanied by a stock clerk. All parts to be renewed are repaired and marked, and a check made of material available.

Gang 1, known as the truck gang, jacks up all cars in the setting. The trucks are run out and the cars let down on trestles or tripods. The trucks are dismantled and all defective or broken parts removed. All arch bars are taken to the blacksmith shop where they are annealed and reset. By this process any cracks or fractures are easily detected. The work of the gang is so regulated, that the trucks are rebuilt, when the car is ready to be let down.

The stripping gang, or gang 2, consists of two car repairers and a sufficient number of laborers to keep the yard clean of scrap lumber. This gang removes all trimmings, defective or broken siding, flooring, lining and roofing, and drops couplers and draft gears. The sill and frame gang follows, removing defective or broken sills, posts, braces, side and end plates, belt rails and other parts of the frame. This gang replaces all parts in the car framing and applies couplers and draft gears.

The fourth operation is performed by the siding gang which applies all siding, side and end fasciae, door tracks and top corner bands. The roofing gang, 5, patches or applies complete roofs with running boards. Gang 6, or the flooring gang, patches or applies new floor boards. This gang is followed by gang 7, which applies or patches end and side lining and grain strips.

The safety appliance gang applies all grab irons, sill steps, lift levers, center corner bands, brake shafts, front and back door stops, and hangs the doors. The doors are repaired or made new and trimmed in the door shop and delivered to the car ready to be hung.

The following gang, consisting of two or more car repairers and apprentices, may be termed a floating gang, doing any steel work required such as straightening and riveting. It works with the sill and framing gang. Gang 10, or the acetylene gang, works wherever needed and has no regular routing to follow.

The air brake men finish the repair work. They apply train line, brake cylinders, reservoirs, and other air brake parts. Where a shipping track is provided, the cars are pulled from the shop track and spotted on the shipping track, where the painters and the air brake men perform their part of the work.

The painters follow closely behind all wood car gangs, painting sills, belt rails and plates ahead of siding, roofing and flooring. The cars are painted and stenciled when the air brakes are tested. After final inspection the cars are ready to be pulled out, and the yardmaster is notified.

Conclusion

What is needed more than anything else is a systematic program for making heavy repairs to freight cars, so that a certain percentage of the equipment will have proper repairs every year. This percentage must be based on the number of years the car can run safely between heavy repairs. Locomotives are shopped on a mileage basis. Why not establish a reasonable and scientific basis upon which to shop freight cars? This will keep the equipment in first class condition at a minimum expense after the program has been once established.

Proper shop facilities should be provided at points where heavy repair work is performed. Overhead crane service is desirable, and will eliminate by proper arrangement the service of materialt rucks between the working tracks. Small wall or jib cranes should be installed for handling heavy parts. The money expended for such facilities will repay the investment many times in a few years.

Snap Shots by the Wanderer

I believe that it was Sydney Smith, who, many years ago suggested that a complete and satisfactory solution of the Irish question would be obtained by a submergence of the Island for twenty-four hours. Drastic but effective, I am not altogether sure, however, that there are not some of us walking about that would be quite willing to advocate a similar treatment for certain incorrigibles whom we run across from time to time. For example, I was talking recently with a couple of engineers who had just returned from the United States of Colombia, where they had been engaged on railroad survey. In speaking of the natives, their worthlessness and unreliability, they proposed a slight modification of Sydney Smith's drastic suggestion, by having the United States of America and England combine and form a military cordon across one end of the country and, with it, sweep every man, woman and child into the ocean. They acknowledged that it would not be a very humane proceeding, but maintained that it would be a grand good thing for the world.

So when I hear of or run across some of the scamp work that is perpetrated I am inclined to think that a prompt lynching of the offending party would be a good thing for the country. Scamping may be the result of one of three things: laziness, dishonesty or cussedness. And I am rather inclined to think that it ought to be made a criminal offense except that we already have too many unenforced laws. But when a man puttys out the lap of a boiler seam, or fills in a nut to make it appear that the bolt extends all of the way through, or fills in the babbitt cavities of a main rod brass with rough steel plates, all of which have been done, thereby endangering lives; well, lynching in the form of drawing and quartering would seem a mild punishment therefor. A boiler explosion or a derailment is no child's play, and some kinds of devilish scamping are almost if not quite impossible for inspection to detect. An inspector's hammer cannot penetrate into every cranny of a boiler and its fixtures, nor can his eyes look through a veneer of babbitt. To require that they did remind one of the celebrated reply of Sam Weller who after having testified that he had not seen Pickwick's arms about Mrs. Bardell, and, being asked if he had eyes, replied: "Yes, I have a pair of eyes, and that's just it. If they wos a pair o' patent double million magnifyin' gas microscopes of hextra power, p'rhaps I might be able to see through a flight o' stairs and a deal door; but bein' only eyes you see, my wision's limited."

So an inspector cannot see everything and I sometimes wonder that he can see much of anything. Certainly he is more than astute if a clever scamper cannot deceive him.

Then there are those insidious fractures by detail that cannot be seen or reached, such as the breakage of driving axles just inside the wheel seat. Or this; I was on a steam boat once, that, on making a landing, struck the wharf rather hard and broke the flange from a valve in the feed pipe. There was a liberal escape of water and steam, and a small panic but no one was hurt. When the valve was removed it was found that there had been an old crack extending half way around its body. It had not leaked but was so weak that the jar caused by the thump against the wharf completed the fracture. No amount of ordinary inspection would have detected that crack.

So there we are, with difficulty upon difficulty staring us in the face when we try to achieve safety by thoroughness of inspection. And when these difficulties are increased by cunning scamping, it looks to even a mild observer like myself as though some form of lynching might be properly used as an antidote.

I believe that I have taken occasion before to remark on the changed attitude of shop owners and managers that has taken place within my memory in regard to shop comforts, and the realization that has come to them that a man will do more and better work in comfortable than in uncomfortable surroundings.

It seems to me that nowhere is this more manifest than in the blacksmith shop. It is not so many years since the blacksmith shop was a most disagreeable place. Cold and suffocating in winter. Hot and stifling in summer. And mostly because of the open fires with their production of smoke and sulphur fumes. As to the amount of harmfulness those accompaniments of forge work possessed for the acclimated workman, I am not prepared to say, but all will admit that they are not the equivalent of good, pure, fresh air.

First we had the open fire, either without a hood or only the chimney at the side, that might carry off a part of the fumes. Then gradually improvements appeared. In the ordinary open fire, smoke can be cared for by sheltering the back and side of the forge with a sheet iron screen and using a flaring bonnet overhead, to guide the smoke to the stack. This can be done without, in any way, impeding the workmen. The bonnet may be telescoped into the stack so as to be raised or lowered and the two sides of the screen can be curved so as to slide in behind the central portion. Then came fans with sufficient capacity to carry off all fumes and create a draft over the fire when it was lighted, sufficient to draw smoke and fumes into the proper channels. This was improved upon by the down draft forges, until now there is no reason why the blacksmith shop should not be as clear and as free from fumes as the machine shop. It has taken many, many years to bring this about, just as it has taken many years to bring about a proper lighting. Many of us can remember the old roundhouse with a few oil lamps and a smoking torch in the hands of every man. Where blinding blackness was everywhere, and the roundhouse was not alone, I remember well working in a car repair shop of a well-known railroad, for more than one long winter evening where the only light came from a multitude of these same smoky torches. Inefficient work was the order of the day. And though wages were much less than they are today when measured by the hour, I doubt not that the cost per unit of work done was nearly if not quite as much as they are now with the hourly wage trebled. All of which is merely one more slight comment on the economic value of comfort.

It is said that a fine actor is one who is so imbued with his art, that that art is concealed. How easily the accomplished acrobat turns a back handspring. Every boy thinks that he can do it, until he tries. With what apparent ease a good workman does his work. It is said, you know, that it takes a good workman to work with poor tools, to which the supplementary observation has been added that a good workman won't work with poor tools.

I stood watching a man the other day and there was something invigorating in the bustle and go, and hurrah boys that filled the air with life and ozone; it was the spirit that makes the fast horse popular, or the seeming vim that the quick-time air of a circus band seems to put into the steady, reliable rhythmic motion of the horse in the ring. But, as I looked, I was reminded of a certain race recorded by one Aesop a few centuries ago, in which a tortoise is said to have beaten a hare. As a race-horse is rarely a good roadster, so the workman, who is always on the jump, rarely outstrips his seemingly slower companion, at the end of the month. It is not necessary to be in an apparent hurry in order to be quick. Hurry means fatigue, for when a man or horse is urged beyond his pace, he soon becomes tired, fretted and exhausted. So when you are dancing in your boots because William is so slow with that rush job, just retrospect a little and remember the last time you were in the same predicament. You were wearing your nerves out with impatience; but, when you did, at last get the work, you were delighted with its accuracy and neatness. So as I have sometimes preached before, the race is not always to the swift, or at least to those who seem swift.

Extensive Use of Telephone in Train Operation

Train orders are now being transmitted by telephone on more than 54 per cent of the railroad mileage of this country, the Telephone and Telegraph Section of the American Railway Association was told at its convention which opened in New Orleans, October 27. On January 1, 1919, reports showed that the telephone was used for train orders on only 46 per cent of the railroad mileage.

The more extensive use of the telephone in place of the telegraph has been due to the increase in traffic, both freight and passenger, on the railroads of this country during the past five years. This has necessitated more prompt, accurate and complete information concerning many matters pertaining to operation and management.

Telegraph Still Being Used

In spite of the widespread use of the telephone, the telegraph is being used for certain purposes, particularly for the transmission of voluminous reports of freight and passenger operation, which serves to relieve the telephone lines of the heavy bulk traffic.

Telephone stations are being installed on many roads at each signal bridge and siding and are connected with adjacent interlocking or block station, so that almost constant communication can be had by train crews with headquarters. In addition, work trains and wrecking trains are also being equipped with portable telephones.

In order to permit signalmen to handle different switch levers without being handicapped by a head telephone, loud speakers connected by wire with the dispatcher's office have been installed by many railroads in signal towers.

Many railroads have also provided means whereby observation cars on certain limited trains are connected by telephone with the city telephone service so that a passenger, up to the time the train departs from the station, can communicate with any point in the city.

The Radio in Railroading

The interest of the carriers in radio communication, it was brought out at the convention, has been intensified by the development of railroad transportation in recent years. In the case of a hundred car freight train, for instance, communication at present can only be had by hand signals between the enginemen and the caboose. This method of signaling is especially difficult at night or where the track curves. Communication between each end of a passenger train is now carrieid on by means of valve signals. In each instance, the operation of long trains would be greatly facilitated were both ends of the train in constant communication by means of radio.

A series of practical tests in the use of radio have already been made on the electrified section of several roads with success but these tests are being continued to see how the system works under varying conditions.

Freight Car Performance

By bringing about the heavier loading of freight cars as well as by expediting their movement, the railroads of this country in August this year showed a marked increase, compared with one year ago, in the efficiency with which freight traffic is being handled, according to reports filed by the carriers with the Bureau of Railway Economics.

The daily average movement per freight car in August was 29.5 miles per day, the highest average ever attained in any August on record. Compared with August last year, this was an increase of 2.9 miles while it also was an increase of 1.2 miles over the average for 1923.

In computing the average movement per day, account is taken of all freight cars in service including cars in transit, cars in process of being loaded and unloaded, cars undergoing or awaiting repairs and also cars on side tracks for which no load is immediately available.

The average load per freight car in August was 27.8 tons, an increase of seven-tenths of a ton compared with August last year. It was, however, a decrease of seven-tenths of a ton below August, 1923.

Considering the heavier loading of freight cars and their faster movement, it is estimated that the shippers of this country received approximately 12 per cent better service during August this year than they did during the same month one year ago. This increased efficiency made it possible for the railways to handle the traffic with 300,000 fewer freight cars than would otherwise have been needed and which would have called for a large additional capital investment on which the public would have paid a return through freight rates.

Fuel Bill Saving in 1925

Class I railroads saved over $23,000,000 on their fuel bill during the first eight months of this year compared with the first eight months of last year, according to figures just compiled by the Bureau of Statistics of the Interstate Commerce Commission.

The total cost of coal and fuel oil for the first eight months of this year was $214,736,375 as against $237,750,593 for the first eight months of last year. This saving of $23,014,218 resulted partly from the decrease in the price of coal and partly from economies effected by the railroad management.

Owing to these economies the railroads moved every 1,000 tons of freight one mile during the first eight months of this year on 12 less tons of fuel than was used in the first eight months of 1924. They also moved every car in a passenger train one mile on 1.0 less pound of fuel in the first eight months of this year than in the same period of last year. In this way, 1,726,018 tons of fuel were saved under the total used in the first eight months of 1924. This represents 859,499 tons saved in freight service and 866,519 tons saved in passenger service.

In the Eastern District 397,336 tons of fuel were saved in freight service, and the railroads consumed 11 less pounds of fuel per 1,000 gross ton-miles of freight.

In the Southern District 139,027 more tons were used in freight service, but 14 less pounds were consumed per 1,000 gross ton-miles.

In the Western District 601,190 tons of fuel were saved in freight service and 12 less pounds were consumed per 1,000 gross ton-miles.

Notwithstanding this saving the railroads increased the average number of cars per freight train from 41.2 in the first eight months of 1924 to 43.5 in the first eight months of this year, and the net tons per train from 702 to 740. In spite of the heavier and longer trains the freight traffic of the country moved 0.4 of a mile faster this year than last. In passenger service the saving of fuel and costs was effected although there was an increase in passenger-train car-miles of 35,884,000 over the total for the first eight months of 1924.

Fifty-One Railroads Using Motor Trucks

Fifty-one steam railroads are listed using motor trucks to handle freight as compared with thirty-three a year ago, according to a survey just completed by the Motor Truck Department of the National Automobile Chamber of Commerce. Twenty steam railroads, or their subsidiaries, are now using over 219 motor buses, it is stated. Details of the survey are given in the following statement:

"Of the railroads using trucks, thirty are doing so under contracts with terminal companies at either Cincinnati or St. Louis by which less than carload freight is interchanged. Thirteen other roads use trucks at other terminals. Twenty-two railroads supply truck service at other points, eight to replace trains carrying package freight, and ten to give store-door delivery in some form.

"Ten of the railroads using motor buses have established routes parallel to some of their rail lines, five have substituted bus for rail service on branch lines, while two are using buses as feeders through territory not previously served by rail. Three railroads are making use of buses through arrangements made with bus operators as to ticket interchangeability or as to service in place of discontinued local trains.

"More extensive use of trucks in the future is indicated by replies showing that fifteen roads are studying the possibilities of transporting freight by truck, contemplating either installing them for the first time or adding to their present truck services.

"That buses will also be used in increasing numbers in the near future is forecast by the fact that eighteen railroads not now using them are contemplating the auxiliary use of buses. Of these, twelve may substitute them for branch line trains, seven consider using them on new feeder routes, and seven are studying the advisability of operating buses on roads paralleling some of their rail lines.

"More than 496 gasoline or gas-electric rail motor coaches are being operated by 190 steam and electric railroads. In the survey made by the same organization one year ago 483 rail motor vehicles were shown to be in use on 174 rail lines.

"Twenty-six of these roads are considering additions to this type of service, having ordered thirty-eight more units. Twenty roads were considering additional rail motor equipment at this time last year. Eighteen other rail lines not now using such vehicles are considering initial installations.

"These figures were taken from data supplied by 201 officials representing 174 railroads and from other sources believed to be reliable. In the survey made a year ago 140 officials representing 125 roads supplied information."

Casualties Decreased in First Half Year

Casualties resulting from train and train-service accidents on the steam railways of the United States for the first half of this year, as reported by the Bureau of Statistics of the Interstate Commerce Commission, show a decrease of 1,925, compared with the first half of last year. There were 362 less passenger casualties and 1,283 less casualties to employes on duty.

Under train accidents are classed those resulting from collisions, derailments, locomotive boiler and other locomotive accidents. Train-service accidents include accidents from coupling or uncoupling trains; operating locomotives, hand brakes and switches; getting on and off locomotives; and accidents at highway crossings, etc.

The total number of casualties resulting from these two classes of accidents amounted to 26,316 for the first half of last year and 24,391 for the first half of this year.

Increased efficiency of railroad maintenance work and the more careful management of trains were responsible for a decrease of 1,720 in the number of train accidents for the first six months of this year under the same period last year.

The total casualties per million locomotive miles decreased from 30.84 in the first six months of last year to 28.85 in the first six months of this year. The passenger casualties per one million locomotive miles decreased from 2.98 to 2.58. The casualties to employes on duty per million man hours decreased from 28.15 in 1924 to 26.69 in 1925.

Campaign to Reduce Freight Damage

An intensive campaign with a view of bringing about still further reductions in loss and damage to freight shipments resulting from rough handling of freight cars, has been inaugurated by the District Freight Claim Conferences comprising the Freight Claim Division of the American Railway Association, according to a recent announcement.

In view of the fact that a majority of the claims are due to rough handling at terminal points, it is the plan of the Claim Conferences to have surveys made at various terminals by a Committee on Rough Handling appointed by each District Claim Conference in cooperation with the railroads entering terminals within their districts. As soon as the surveys have been completed the Committee will make recommendations to suit conditions in those terminals in an effort to bring about a reduction in loss and damage claims growing out of the rough handling of freight cars at those points.

Rough handling of freight cars not only causes damage to freight in transit but it also causes considerable damage to railroad equipment so that the members of the Committee hope not only to bring about a saving to shippers but also to the railroads as well.

A survey of various terminals in the Southern Atlantic States is already under way.

In connection with the situation at St. Louis and East St. Louis the Local Committee has recommended that steps be taken to reduce to a minimum the amount of switching in that terminal and that, where switching is necessary, it be done under certain restrictions to minimize the opportunities for damage. The Committee has also recommended that closer attention be given by trainmen to the transmission of signals to the enginemen and that, where there is a space between cars on a siding, it be closed by shoving rather than by having the engine "kick" a car.

It is hoped to begin surveys at various other large terminals in the near future.

Notes on Domestic Railroads

Locomotives

The New York Central Railroad has ordered for Boston & Albany Railroad, 25 heavy freight 2-8-4 type locomotives from the Lima Locomotive Works.

The Union Pacific Railroad contemplates ordering one new 3-cylinder locomotive with a 4-12-2 wheel arrangement.

The Central of Georgia Railway is inquiring for 5 Mountain type locomotives.

The Ulen & Co., Colombia, South America, has ordered 6 Mikado type locomotives from the Baldwin Locomotive Works.

The Hocking Valley Railway has ordered 10 switching 0-8-0 type locomotives from the Lima Locomotive Works.

The Tennessee Central Railroad has ordered 4 Mountain type locomotives from the American Locomotive Company. These locomotives will have 23 in. by 28 in. cylinders and a total weight in working order of 264,000 lb.

The Coste de Minas E. de F., Brazil, has ordered 7 Pacific type locomotives from the Baldwin Locomotive Works.

The Chilean State Railways has placed orders for 12 Mikado type locomotives with the American Locomotive Company.

The Atlanta & West Point Railway is inquiring for 4 Mikado type locomotives.

The Chesapeake & Ohio Railway has placed an order for 5 165-ton Pacific type locomotives with the American Locomotive Company. These locomotives will have 27 in. by 28 in. cylinders and total weight in working order of 336,000 lb.

The Cerro de Pasco Copper Corporation has placed orders for 12 Mikado type locomotives with the American Locomotive Company.

The New York, New Haven & Hartford Railroad has ordered 10 Mountain type locomotives from the American Locomotive Company.

The New York Central Railroad has ordered 100 182-ton Mohawk type locomotives from the American Locomotive Company. These locomotives will have 27 in. by 30 in. cylinders, and a total weight in working order of 368,000 lb.

The Missouri Pacific Railroad is inquiring for 10 heavy Santa Fe type locomotives.

The Jeffrey Manufacturing Company, Columbus, Ohio, is inquiring for one electric locomotive.

The Central Cuba Sugar Company has ordered 3 Mogul type locomotives from the Baldwin Locomotive Works.

The Long Island Railroad has placed an order for one of the new type of oil electric locomotives being built jointly by the American Locomotive Company, the General Electric Co., and the Ingersoll-Rand Company. The locomotive is to be placed in service at the Bushwick terminal.

The Central Railroad of New Jersey has purchased one, 60-ton oil electric locomotive being built jointly by the American Locomotive Company, the General Electric Co., and the Ingersoll-Rand Company. The locomotive is to be placed in service within a few weeks' time and will be used in the New York district.

The Chesapeake & Ohio Railway has ordered 20 heavy Mallet type locomotives from the Baldwin Locomotive Works, to cost approximately $2,250,000.

The Louisville & Nashville Railroad has ordered 8 Mountain type locomotives from the Baldwin Locomotive Works.

The American Railway of Porto Rico has ordered one Consolidation type locomotive from the Baldwin Locomotive Works.

The Denver & Rio Grande Western Railroad contemplates buying 10 locomotives.

The Chicago South Shore & South Bend Railway has ordered 4 electric locomotives from the Westinghouse Elec. & Mfg. Company to cost $55,000 each.

Passenger Cars

The Chicago South Shore & South Bend Railway has placed orders for 15 smoking-passenger cars and 10 smoking-passenger baggage cars from the Pullman Car & Mfg. Company.

The St. Louis-San Francisco Railway is inquiring for 12 standard steel coaches.

The Missouri Pacific Railroad is inquiring for 5 standard steel dining cars.

The Louisville & Nashville Railroad has placed an order for 14 passenger cars with the Pressed Steel Car Company, 22 passenger cars with the American Car & Foundry Company.

The Cuba Railroad Company is inquiring for some first-class and second-class passenger cars.

The Missouri Pacific Railroad has ordered 15 all-steel baggage cars from the American Car & Foundry Company.

The New York, New Haven & Hartford Railroad has placed an order for 35 multiple-unit passenger cars with Osgood-Bradley Company.

The Chesapeake & Ohio Railway has placed orders for 10 passenger baggage cars with the Bethlehem Steel Company.

The Long Island Railroad is inquiring for 20 steel coaches for steam line service.

Freight Cars

The Atlantic Coast Line Railway has ordered 750 low side gondola cars of 50-ton capacity from the American Car & Foundry Company.

The Central of Georgia Railway has ordered 2,000 ventilated box cars from the Tennessee Coal, Iron & Railroad Company.

The Illinois Central Railroad is inquiring for 200 double-deck stock cars.

The Sinclair Refining Company is inquiring for 50 tank cars of 10,000-gallon capacity.

The Missouri Pacific Railroad is inquiring for 250 stock cars and 500 box cars of 50-ton capacity.

The Chesapeake & Ohio Railway has ordered 4 air dump cars from the Case Crane & Engineering Company.

The Wabash Railway has placed an order for 12 automobile box cars with the American Car & Foundry Company.

The Armour & Company, Chicago, Ill., is inquiring for 50 steel underframes for tank cars.

The New York Central Railroad is inquiring for 1,000 box cars.

The Louisville, Henderson & St. Louis Railway is inquiring for 4 caboose cars.

The Missouri Pacific Railroad is inquiring for 1,000 automobile box, stock and coal cars.

The Denver & Rio Grande Western Railroad is inquiring for 200 50-ton box cars and 500 50-ton general service gondola cars.

The Montour Railroad has ordered 500 hopper cars from the Standard Steel Car Company.

The Missouri Pacific Railroad is inquiring for 1,500 40-ton box cars and 500 automobile cars and 250 50-ton hopper cars.

The Louisville & Nashville Railroad has placed an order for 1,000 additional gondola cars with the Pressed Steel Car Company.

The Atlantic Coast Line Railway is inquiring for 500 composite box cars.

The International Great Northern Railway is inquiring for 1,900 automobile and box cars.

The Jackson Hill Coal & Coke Company has ordered 20 mine cars from the American Car & Foundry Company.

The St. Louis-San Francisco Railway is inquiring for 500 composite gondola cars and 500 automobile box cars.

The New York, Chicago & St. Louis Railway is inquiring for 100 steel underframes for box cars.

The Canadian Pacific Railway is inquiring for 100 dump cars for handling rock and ore.

The United Alloy Steel Company is inquiring for 15 50-ton gondola cars.

The Chesapeake & Ohio Railway has placed an order with the Hocking Valley Railway for the construction of 25 steel underframe cabooses to be built at Logan, Ohio.

The Illinois Central Railroad has placed orders for 200 flat cars with the Standard Steel Car Company.

The Valvoline Oil Company, Butler, Pa., has placed an order for 10 40-ton tank cars of 8,000-gallon capacity with the Standard Tank Car Company.

The Canadian Pacific Railway has placed an order for 100 box cars with the Canadian Car & Foundry Company.

The National Tube Company is inquiring for 50, 70-ton hopper bodies.

The Indian Refining Company has placed an order for 10 triple-compartment 8,000-gallon tank cars with the Standard Tank Car Company.

The Hymera Coal Company has ordered 50 wooden mine cars from the American Car & Foundry Company.

The Chicago, Milwaukee & St. Paul Railway is inquiring for 2 special flat cars and 2 Well-type cars.

The Richmond Dale Coal Company has ordered 25 mine cars from the American Car & Foundry Company.

The Kansas City, Mexico & Orient Railway is inquiring for 50 single-sheathed automobile box cars.

The Baltimore & Ohio Railroad has placed orders for 1,000 box cars with the Bethlehem Steel Company and 500 box cars with the Standard Steel Car Company.

The Armour & Company, Chicago, Ill., has placed orders for 300 steel underframes with the Bettendorf Company.

The Chesapeake & Ohio Railway has placed an order for 100 steel underframe caboose cars with the Standard Tank Car Company.

The Palace Poultry Company, Chicago, Ill., has placed an order for 150 poultry cars with the Illinois Car & Mfg. Company.

Buildings and Structures

The Texas & Pacific Railway has placed a contract covering the construction of a seven-stall roundhouse, a machine shop, a car repair shed and other buildings at Dallas, Texas, to cost approximately $135,000.

The Virginian Railway has placed a contract covering the erection of equipment at the sand handling plant at Mullens, W. Va. The equipmept to be furnished by Roberts & Schaefer Company, Chicago, Ill.

The Illinois Central Railroad has placed a contract covering the erection of an office building and an extension to its blacksmith shop at Paducah, Ky.

The Southern Pacific Company has ordered one N. & W. type cinder plant for erection at Globe, Ariz., from the Roberts & Schaefer Company, Chicago, Ill.

The Pennsylvania Railroad plans extensions and improvements at Weirton Junction, W. Va., including a new roundhouse and machine shop.

The Wabash Railway plans the construction of new yards at Decatur, Ill.

The Chesapeake & Ohio Railway plans the construction of a coaling station at Olive Hill, Ky.

The Chicago, Rock Island & Pacific Railway has placed an order covering two junior cinder plants for installation at Shawnee, Okla., with the Roberts & Schaefer Company, Chicago, Ill.

The New York Central Railroad has placed contracts covering the construction of circuit breaker houses at Port Morris, Luzerne and Melrose, N. Y.

The Pennsylvania Railroad has placed a contract covering the construction of a reinforced concrete automatic electric simplex roller skip locomotive coaling plant for installation at Phillipsburg, N. J., with the Roberts & Schaefer Company, Chicago, Ill.

The Kentucky & Indiana Terminal Railroad is reported to be planning the construction of a new office building and a machine shop at Louisville, Ky., to cost approximately $82,000.

The Southern Pacific Company plans for the construction of a roundhouse at Santa Barbara, Calif., to replace a building which was recently destroyed by an earthquake.

The Jacksonville Terminal Company has placed an order for one standard N. & W. type cinder plant for installation at Jacksonville, Fla., with the Roberts & Schaefer Company, Chicago, Ill.

The New York Central Railroad has placed a general contract covering the construction of a machine shop at Air Line Junction, Ohio, with the K. Ferguson Company, Cleveland, Ohio.

The Union Pacific Railroad has placed a contract covering the erection of a new house with repair facilities at Marysville, Kans., to cost approximately $75,000 with equipment.

The Central of Georgia Railway has awarded a contract to the Roberts & Schaefer Company for two N. & W. type junior electric cinder plants at Albany, Ga.

The Chicago, Rock Island & Pacific Railway plans the construction of an additional 14 stalls for its roundhouse at Silvis, Ill., which, with the extension of the pits is estimated will cost approximately $75,000.

The Los Angeles & Salt Lake Railroad is installing a 100 ft. pony truss turntable equipped with an electric tractor at Milford, Utah, at an estimated cost of $44,000 with company forces.

Item of Personal Interest

W. E. Wooden has been appointed general foreman of freight car department of the Southern Railway, with headquarters at Hayne, S. C., succeeding C. H. Bradley, resigned. **C. W. Creger** was appointed assistant foreman, and **H. D. Snyder** was appointed assistant foreman of the air brake shops at Hayne, S. C.

F. M. Reed has been made motive power inspector of the Pennsylvania Railroad, with headquarters at New York, N. Y.

O. C. Branch has been appointed road foreman of engines on the Seaboard Air Line, with headquarters at Hamlet, N. C., succeeding **O. D. Blackwell**, transferred. **George B. Riddle** was appointed assistant road foreman of engines at Hamlet, N. C.

Charles W. Extrand has been appointed road foreman of engines on the Northern Pacific Railway, with headquarters at Minneapolis, Minn.

George H. Massy has been appointed roundhouse foreman of the Central Railroad of New Jersey, with headquarters at Elizabethport, N. J., and **J. J. Martin** has been appointed roundhouse foreman at Phillipsburg, Pa.

F. W. Foltz has been appointed inspector of transportation on the Missouri Pacific Railroad, with headquarters at St. Louis, Mo., succeeding **T. A. Stainthrop.**

G. T. Patton has been appointed car foreman of the Baltimore & Ohio Railroad shops, freight car department, at Baltimore, Md.

S. J. Starke has been appointed general foreman of the International Great Northern Railway, with headquarters at Mart, Tex., succeeding **V. N. Potts.**

James W. Gibbons has been appointed general foreman of the passenger car shop of the Santa Fe Railway at Topeka, Kans., succeeding **H. J. Neiswinter**, retired.

H. M. Warden has been made mechanical superintendent of the Missouri-Kansas-Texas Railroad, with headquarters at Parsons, Kans., succeeding **C. M. Hatch**, resigned.

A. H. Keys has been made general car foreman of the Baltimore & Ohio Railroad shops at Baltimore Terminals.

W. J. Siffin was appointed general foreman, Ft. Wayne division, Lake Erie & Western district of the New York, Chicago & St. Louis Railroad, with headquarters at Muncie, Inc., vice **J. H. Dunn**, promoted to roadmaster, Middle division, Lake Erie & Western district, with headquarters at Tipton, Ind., succeeding **W. S. Fife**, transferred as supervisor of track, Ft. Wayne division, with headquarters at Belleville, Ohio, succeeding **G. Blair**, resigned.

H. Y. Harris has been appointed master mechanic of the Seaboard Air Line Railway, with headquarters at Tampa, Fla. **W. A. King** has been appointed road foreman of engines, with headquarters at Wildwood, Fla.

F. B. Moss has been appointed master mechanic of the Richmond division of the Chesapeake & Ohio Railway, with headquarters at Richmond, Va., succeeding **M. Flanagan.**

F. M. Darden, assistant car foreman of the St. Louis-San Francisco Railway, with headquarters at Springfield, Mo., has been appointed general car foreman of the west freight shop, with the same headquarters to succeed **G. W. Thomas.**

Leslie H. Tyler, special representative, public relations department, of New York, New Haven & Hartford Railroad, with headquarters at New York, has been transferred to New Haven, Conn., in the same position. The New York office will be in charge of **George S. Wheat.**

R. G. McKee has been appointed master mechanic of the Chicago division of the Chesapeake & Ohio Railway, with headquarters at Peru, Ind., succeeding **E. R. Woody.**

M. H. Gold, has been appointed superintendent of the East Florida division of the Seaboard Air Line, with headquarters at West Palm Beach, Fla.

H. D. Polland, general manager of the Central of Georgia, with headquarters at Savannah, Ga., has been given the title of vice-president and general manager, with the same headquarters.

F. J. Swentzel and **Arnold Lawson** have been appointed superintendents of the New England Transportation Company, a subsidiary of the New York, New Haven & Hartford Railroad.

Frank R. Pechin, formerly general superintendent of the Chicago, St. Paul, Minneapolis & Omaha Railway, with headquarters at St. Paul, Minn., has been appointed to general manager, to succeed **J. J. O'Neil.**

William H. Farrell has been appointed assistant to vice-president of the Canadian National Railways, with headquarters at Montreal, Canada.

George E. Bonner has been appointed superintendent of the Northern Iowa division of the Chicago & Northwetsern Railway, with headquarters at Mason City, Iowa.

J. A. Small, formerly superintendent of the Southern Pacific Railroad Co. of Mexico, has been appointed general manager, with headquarters at Mazatlan, Sinaloa, Mexico.

F. D. Davis has been appointed acting general superintendent of the Pennsylvania Railroad, with headquarters at New York, N. Y., with jurisdiction over the New Jersey division, pending the recovery of **William B. Wood.**

Supply Trade Notes

The Davis Boring Tool Ccmpany, St. Louis, Mo., has made the following changes in its sales department: **William Morgan**, formerly special representative in New York, Philadelphia and Baltimore for the past nine years, has been appointed representative, with headquarters at New York City. **M. S. Hatch**, formerly supervisor of machinery of the Missouri-Kansas-Texas Railroad, has been appointed representative in the New England district and **W. E. Moberly**, formerly of the American Car & Foundry Company, has been appointed special railroad sales representative, with headquarters at St. Louis, Mo.

The Standard Steel Car Company has awarded a general contract to the Austin Company, Chicago, Ill., covering a one-story addition to its shops at Hammond, Ind.

D. K. Chadbourne has been appointed general manager of the Westinghouse Electric International Company, succeeding **E. D. Kilburn**, who has been elected vice-president of the Westinghouse Electric & Manufacturing Company.

R. A. McHenry has been appointed purchasing agent for the **Gould Coupler Co.**, with headquarters at Depew, New York. Mr. Henry was formerly purchasing agent for **The Symington Company.**

W. N. Agnew has been appointed general traffic manager of the **Worthington Pump & Machinery Corporation**, with headquarters at New York City.

R. R. Davis has been appointed assistant manager of the publicity department of the **Westinghouse Electric & Manufacturing Company.**

F. S. Hartwell has been appointed western New York sales representative for the **Davis Boring Tool Company**, St. Louis, Mo., with headquarters at Rochester, N. Y. Mr. Hartwell was formerly general tool foreman of the Texas & Pacific Railway.

W. H. Finley, former president of the Chicago & Northwestern Railway, has opened an office for practice as consulting engineer at 1102 Chamber of Commerce Building, Chicago, Ill.

John W. White has been appointed general manager of the **Westinghouse Electric & Manufacturing Company** of Japan. He was formerly manager of the Havana office of the **Westinghouse International Company.**

John B. Emerson has been elected vice-president of the **R. H. Laverie & Sons, Inc.**, inspection engineers, and will be in charge of the Chicago office of that company. Mr. Emerson was formerly engineer of tests of the rail committee of the American Railway Association.

J. E. Tarleton representative of the **Union Draft Gear Company** has been promoted to assistant to L. T. Canfield, vice-president in charge of sales.

The Railway Motor Car Co., Waycross, Ga., has been incorporated with $50,000 capital to manufacture railway motor cars.

The General American Tank Car Corporation has organized a subsidiary to be known as the **General American Tank & Storage & Terminal Co.**, which will engage in the storage and transportation of oil.

J. P. Carney, formerly general car inspector of the Michigan Central Railroad, with headquarters at Detroit, Mich., has joined the sales force of the **Grip Nut Company.**

H. B. Green has been appointed Pacific coast representative of the **Graham Bolt & Nut Co.**, Pittsburgh, Pa., with headquarters in the Monadnock Building, San Francisco, Calif.

E. C. Hallquist has been appointed chief mechanical engineer of the plant of the **Commonwealth Steel Co.**, at Granite City, Ill.

Joseph T. Ryerson & Son, Chicago, have taken over the line of horizontal drilling and boring machines manufacturing by the **Harnischfeger Corp.**, of Milwaukee, Wisc.

E. D. Kilburn and **W. S. Rugg** have been elected vice-presidents of the **Westinghouse Electric & Mfg. Co.**, and **Richard B. Mellon** has been elected a director, to succeed **William McConway**, of the **McConway & Torley Co.**, deceased.

A. E. Kistner has been appointed manager of the Cincinnati office of the **Truscon Steel Co.**, succeeding **A. Levinson.**

Robert W. Hunt Co., inspecting and testing engineers, have opened a branch office and cement laboratory at Birmingham, Ala., in charge of **T. C. Peace** as manager.

G. R. Ingersoll, of the Associated Materials Company, Cleveland, Ohio, has been appointed exclusive representative of the **Morten Manufacturing Co.** for the sale of its Acme line of railway appliances in the Cleveland district.

The General American Tank Car Corporation has established southern sales offices at Union Indemnity Building, New Orleans, La., which will be in charge of **Z. R. Simon** as sales manager.

The Southern Wheel Company, Pittsburgh, Pa., is contemplating the construction of a plant in St. Louis, Mo.

A. A. Helwig, superintendent of car department of the Kansas City Terminal, has joined the sales organization of the Bradford Corporation, New York. He will have his headquarters at St. Louis, Mo.

The Standard Steel Car Company has awarded a general contract for the construction of a one-story addition and improvement to its present shop at Hammond, Ind., to cost approximately $200,000 with equipment.

L. M. Zimmer has been appointed general sales manager of the **Linde Air Products Company**, manufacturers of oxygen, and of the welding gas division of the Prest-O-Lite Company, Inc., manufacturers of dissolved acetylene, succeeding **L. M. Moyer**, who resigned August 1, 1925. Mr. Zimmer entered the employ of the Linde Company nine years ago as junior salesman, and has steadily risen in rank. Most of the time he has represented the company in the Central West, going to New York early in 1924 to act as assistant general sales manager.

Obituary

Gecrge M. Basford, railroad publicist and engineer and head of the G. M. Basford Company, and consulting engineer of the Lima Locomotive Works, Inc., 17 East 42nd Street, New York, dropped dead in the Jerome Avenue subway station in New York on Monday evening, October 26. Mr. Basford was recognized as a strong and constructive leader in several phases of railroad activity. He was, for instance, one of the organizers and has been familiarly called the father of the Railway Signal Association, which now includes in its membership signal officers of all the important railroads in North America. While he was enthusiastic about railway signaling from the safety standpoint, he early recognized its tremendous possibilities in increasing the capacity of the plant and thus providing more efficient and economical operation.

Possibly Mr. Basford was better known, however, because of the pronounced influence which he had on the improvement of steam locomotive design and utilization. His keen vision enabled him to see the possibilities of growth and improvement of the steam locomotive and for at least three decades he was far in the vanguard in this respect. Mr. Basford also must be credited with having been among the first in the mechanical engineering fraternity to recognize the importance of the human element as contrasted to materials and methods. He was constantly on the lookout for promising young men who could be encouraged to train themselves for positions of leadership. After all that can be said regarding his accomplishments, the highest thing that can be said about him was his willingness and ability to help others. There are hundreds of men occupying, many of them through his help, prominent positions who in times of stress have turned to him for guidance and who will learn with the deepest regret of his death. The gratitude and love of these men is one of the highest tributes that can be paid to a fellowman. While he was most widely known in this respect because of his leadership in introducing modern apprenticeship methods in the mechanical department on the railroads, this was only one of several ways in which he exerted a real influence in helping to raise the standards and provide bigger and better men for future leadership. Mr. Basford's entrance into the field of technical advertising brought to bear a larger emphasis on certain important features of advertising which had been largely neglected up to that time. As a specialist in that field in recent years he has been a large factor in raising the standards and making the advertising pages more effective.

George M. Basford

Mr. Basford was born in Boston in 1865, where he attended the public schools. He was graduated from the Massachusetts Institute of Technology in 1889, after which he entered the Charlestown shops of the Boston & Maine, later going to the Chicago, Burlington & Quincy as a draftsman at Aurora, Ill. He left the Burlington to take a position in the motive power department of the Union Pacific, and was connected with the test department of that road for some time, after which he entered the service of the Chicago, Milwaukee & St. Paul as signal engineer. Later he was superintendent of construction of the Johnson Railway Signal Company, was with the Union Switch & Signal Company for a short time, and then became signal engineer of the Hall Signal Company. In 1895 he became mechanical department editor of the Railway and Engineering Review, and in 1897 was made editor of the American Engineer and Railroad Journal, now the Railway Mechanical Engineer. In September, 1905, he was made assistant to the president of the American Locomotive Company, and in March, 1913, became chief engineer of the railroad department of Joseph T. Ryerson & Son. Mr. Basford organized the G. M. Basford Company to handle technical advertising in March, 1916. At about this time he was also made president of the newly organized Locomotive Feedwater Heater Company and headed it for several years until it was taken over by the Superheater Company.

Mr. Basford, when he was with the American Locomotive Company, was called upon to give part of his time to help build the Railway Business Association, and rendered splendid service in helping to start the association off right. He has always been keenly interested in strengthening and improving the work and programs of various railroad associations and other organizations with which he has been connected. His paper presented before the 1905 convention of the American Railway Master Mechanics' Association on "The Technical Education of Railway Employees—the Men of the Future," is typical of the care and thought that he put into the addresses which he made before different railroad associations and clubs.

In addition to the Railway Signal Association, of which Mr. Basford was a charter member, he was a member of the New York Yacht Club, Lotus Club, Engineers' Club, New York Athletic Club, New Rochelle Yacht Club, American Society of Mechanical Engineers and the New York Railroad Club, and other railroad clubs in various parts of the country.

Mr. Basford lived at 134 Primrose Avenue, Mount Vernon, N. Y. He is survived by his wife, Grace Barker Basford, and by two daughters, Mrs. Roger L. Wensley, who lives in Brooklyn, N. Y., and by Miss Jean Basford, who is now in Paris.

George Adams Post, president of the George A. Post Company, manufacturers of railroad supplies and chairman of the Railroad Committee of the United States Chamber of Commerce, died on October 31, of a sudden attack of heart disease at his home at Somerville, New Jersey.

Mr. Post was born at Cuba, New York, September 1, 1854, and spent most of his youth at Owego, New York. He was educated in the public school there. His father, Ira A. Post had been connected with the Erie Railroad for over fifty years. When 18 years old Mr. Post entered the service of the Erie road in the freight department and remained there until he was advanced to assistant to the superintendent of motive power.

He was elected Mayor of Susquehanna, Pa., at the age of 22 and six years later he went to Congress as the youngest member on its roster. He had studied for the bar while employed in the freight department of the Erie Railroad, and was admitted to practice in Pennsylvania.

He moved to New York City in 1889 and became the editor of the New York World until 1892, when he entered the railroad supply business as vice-president of the Standard Coupler Company assuming the presidency in 1894.

As chairman of the executive committee of the Railway Supply Manufacturers' Association in 1904 in connection with the convention of Master Car Builders and the Master Mechanics he helped effect the permanent Railway Supply Manufacturers' Association. He was chairman of the American Railway Appliance Exhibition at Washington, D. C., in 1905, and became the first president of the Railway Business Association in 1909, holding office for nine years.

Mr. Post was ex-president of the Machinery Club and also a member of the Lotos and Railroad Clubs.

George E. Crisp, treasurer of the Superheater Company, died after a prolonged illness at his home in East Orange, New Jersey, on October 11, 1925. Mr. Crisp was born February 16, 1870, and received his education at Albert Memorial College, London, England. He traveled extensively in the United States and Canada, and after being identified with the early development of the Canadian Northwest, started railroading on the Chicago & Great Western Railway. Mr. Crisp had been associated with the Superheater Company for ten years. Prior to coming with this company he had been associated with other railroad supply companies and was well known in that field.

Fred Zimmerman, president of the Cincinnati, Indianapolis & Western Railroad, died suddenly on October 5, at a sanitarium at Battle Creek, Mich., after a prolonged illness. He was born on July 26, 1866, at Portland, Maine, and educated in the public schools in Chicago. He entered railway service in 1882. He held various positions in freight departments of several roads in and about Chicago. In 1897 he entered the service of the Michigan Central Railroad in the general freight department, and in 1897 was promoted to assistant general freight agent, with headquarters at Buffalo, N. Y. He was transferred to Chicago the following year where he remained until 1909, when he was appointed general freight agent of the Indian Harbor Belt Railroad of Chicago. In March, 1914, he became general freight agent of the Lake Shore & Michigan Southern Railway at Cleveland, Ohio. He was elected vice-president in charge of traffic of the Chicago, Indianapolis & Louisville Railway, with headquarters at Chicago, in 1914, and in 1923 he was elected president of the Cincinnati, Indianapolis & Western Railroad, in which capacity he was serving at the time of his death.

C. E. James, president of the Tennessee, Alabama & Georgia Railway, with headquarters at Chattanooga, Tenn., died in Chattanooga on October 2, after several weeks' illness.

William H. Scriven, superintendent of the Chicago terminal division of the Pennsylvania Railroad, was killed in an automobile in which he was riding when it left the road and rolled down an embankment near Carbondale, Ind. Mr. Scriven was born on March 18, 1860, and entered railway service in 1881 with the Mexican National Railroad, becoming associated with the Pennsylvania lines west of Pittsburgh in 1882. In 1886 he was appointed assistant engineer of maintenance of way and in 1880 he became engineer maintenance of way of the Cleveland & Pittsburgh division of the Pennsylvania Railroad and was transferred to eastern division in the same capacity in 1895. In 1896 he was appointed superintendent of the division and in 1903 he was appointed superintendent and general agent of the Chicago terminal division, which position he held until his death.

New Publications

Books, Bulletins, Catalogues, etc.

Locomotive Superheaters: The Superheater Company of New York and Chicago have just issued a fourth edition, revised, of their Instruction book on the locomotive superheater, giving instructions for installation, operation, maintenance and repairs. This edition supersedes the edition issued in 1917. It has been completely revised and gives latest recommendations relative to the Elesco Type "A" Superheater. Questions and answers are given in the back of the book covering the principle of superheating generally. 87 pages and cover, 4½x6 inches.

Chicago, Milwaukee & St. Paul Electrification. The progress in electrification accomplished by the Chicago, Milwaukee & St. Paul Railway is described in the 44-page bulletin, GEA-150, just issued by the General Electric Co., Schenectady, N. Y. The profusely illustrated book takes up in detail all of the equipment, including locomotives, substations, power supply, and transmission and overhead construction. In addition to photographs of equipment, there are numerous maps, diagrams and tables of specifications. Figures are presented to show the comparative cost of electric and steam operation. Copies of the bulletin may be secured by addressing the News Bureau, General Electric Co., Schenectady, New York.

The Austin Book of Buildings. The Austin Company, Cleveland, Ohio, has recently issued the eighth edition of its general catalog which contains illustrations and specifications of Austin standard multi-story and single-story buildings. It contains charts and tables showing the trend of building costs and comparative insurance rates and the technical description and costs of various types of floors, walls, roof structures and various other items pertaining to building cost. Copies of the catalog may be secured by addressing the Austin Company, Cleveland, Ohio.

The Railway of Mexico. This volume has just been issued by the Department of Commerce. It is the second of a series of which the first was on the Railway of Central America and islands of the West Indies, covering all the countries of South America. The one on Argentina is now on the press and should be available for distribution shortly. This volume on Mexico contains technical, financial and historical information on all railways operated in these countries. This volume was prepared from a great variety of sources by W. Rodney Long, of the transportation division of this bureau. The monograph presents very detailed information on all the railways in this territory, covering such phases as the development of the line, the mileage, operating officials, method of purchases, finances, traffic statistics, characteristics of the right of way, number of employees, motive power and rolling stock, repair shops and equipment.

The volume was prepared through co-operation between the transportation division and various locomotive and car-building companies, manufacturers of railway equipment, exporters of cross-ties and other interested companies, together with the machinery division and the iron and steel division of the bureau.

Request for copies of this volume should be addressed to the Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C.

Electric Railways and the American Public. This is a bulletin issued by the General Electric Co., Schenectady, N. Y. It is a collection of recent and forthcoming odvertisements which explains the electric railways and their functions, and is presented in pamphlet form. It shows methods by which railway companies can tie in with national advertising as outlined in the introduction. Copies can be obtained by addressing your nearest General Electric office.

The Standard Milburn Regulators. The Alexander Milburn Company of Baltimore, Md., have recently published a bulletin pertaining to Standard Milburn Regulators. This bulletin illustrates oxygen, acetylene and hydrogen regulators, gauges, adaptors, etc., and standard manifolds for oxygen, acetylene and other gases. It shows the detail construction of Milburn regulators and fully describes all of this equipment. Copies of this circular may be had by addressing the Alexander Milburn Company, 1416-1428 West Baltimore street, Baltimore, Md.

Railway Accounting Officers' Association, Forty-first Report. Published by the Railway Accounting Officers' Association, Washington, D. C. It contains in full all addresses delivered, paper read and committee reports and discussions held in connection with its thirty-seventh annual session, which was held at Atlantic City on June 10 to 12, 1925. Request for copies of this report should be addressed to the above address.

Elesco Non-Contact Type Feed-water Heater. The Superheater Company, 17 East 42nd street, New York, N. Y., has just issued a new catalog describing and illustrating the theory, construction and application of Elesco Non-Contact type of locomotive feed-water heater. This catalog is a treatise on steam production and its utilization in locomotives. The diagrams accompanied by text, show the increase in efficiency of the locomotive through the application of a feed-water heater, and the savings under varying conditions are shown. The latest designs are illustrated and a number of installations are shown. Copies may be secured on application to the Superheater Company.

Railway and Locomotive Engineering

A Practical Journal of Motive Power, Rolling Stock and Appliances

Vol. XXXVIII 136 Liberty Street, New York, December, 1925 No. 12

A Summary of Tests Obtained with Lima Locomotives

Interesting Results of Five Years of Experimental Work

It is not often that the economic results of five years of intensive experimental work and the expenditure of many thousands of dollars can be summed up and set forth on a single sheet of paper. Such results, however, are given in the accompanying diagram of the successive investigations that have been made by the Lima Locomotive Works upon three locomotives that represent the three stages of the development under consideration.

In 1922 the Mikado (2-8-2) locomotive represented on the diagram by a reproduction of a photograph of No. 4008, was considered as fine an example of locomotive construction as was then in existence. It had cylinders 27 in. in diameter with a piston stroke of 30 in.; a weight of 246,000 lbs. upon the drivers, 4,650 sq. ft. of evaporative heating surface and a tractive force of 59,000 lbs. which developed a drawbar pull of 51,150 lbs, that still held up to nearly 30,000 lbs. at 25 miles an hour. It was efficient and economical in the production of its power, and was regarded as an entirely satisfactory freight locomotive.

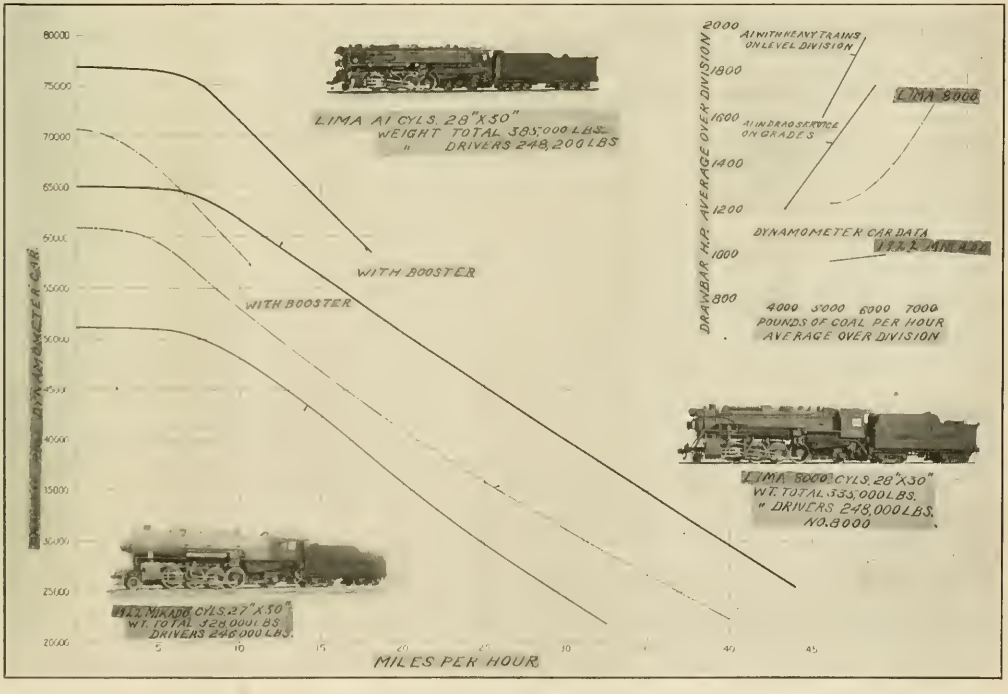


Diagram of Results of Tests of a Representative Mikado Type Locomotive of 1922 and Lima Locomotives, the 8000 and the New 2-8-4 Type

Shortly after that time a rumor was circulated that the officials of the Lima Locomotive Works were engaged in the designing of a locomotive, which was expected to be a good deal superior to the locomotive under consideration. And in August 1922 a description of the new machine was published in Railway & Locomotive Engineering.

This was the much-heralded No. 8000.

The designers had put 2,000 lbs. more upon the driving wheels and had increased the cylinder diameters to 28 in. The fire box had been widened 9 in. and the total combined evaporative and superheating surface had been increased by a little more than 500 sq. ft.; though the actual evaporative heating surface had been decreased. The steam pressure, however, had only been raised 10 lbs. per sq. in.; but this, with the 1 in. increase in cylinder diameter, raised the tractive force to 66,700 lbs. which was raised to 77,700 lbs. by the addition of a booster. This increase raised the starting drawbar pull of the engine to 61,000 lbs. which rose to 70,700 lbs, when the booster was in operation. The booster could be kept in effective and satisfactory operation up to a little more than 10 miles an hour, at which speed the engine draw bar pull was about 53,000 lbs. which became about 58,400 with the booster added. This was an increase from about 48,000 lbs. with the representative Mikado of 1922, or 10.4 and 21.7 per cent. respectively.

It was at about fifteen miles per hour that the difference in the drawbar pull of the two engines was at its minimum. At higher speeds the lines separated until at 30 miles an hour the figures stood at about 24,450 lbs. and 31,100 lbs. respectively, or an increase in drawbar pull of 27.2 per cent or more than the balance at 10 miles an hour with the booster in operation. To put it in another way the drawbar pull of the new design at 30 miles an hour was as much as that of the old one at less than 24 miles an hour.

And all this was accomplished by an increase in total weight of but 7,000 lbs. of which 2,000 lbs. were upon the driving wheels.

Not only was the superiority shown in the drawbar pull but it was emphasized by the horse-power developed per pound of coal burned.

In these several test runs average results over the division shows that when burning 5,000 lbs of coal per hour the representative 1922 Mikado developed about 970 horse-power which was increased to about 1,000 horsepower, by raising the coal consumption to 6,000 lbs. per hour. In other words an increase of coal consumption of 20 per cent. increased the drawbar horse-power about 3.1 per cent.

On the other hand, a consumption of 5,000 lbs. of coal per hour in the firebox of the 8000 developed about 1,225 drawbar horsepower, which rose to about 1,320 when the coal consumption was increased to 6,000 lbs. or an increase of nearly 8 per cent. for the extra expenditure in coal.

Such advantages as these were not to be ignored and the demonstration of the efficiency of this locomotive was followed by orders for several hundred of the same.

Not being convinced that the last word in locomotive design had been said in the production of the 8000, the builders turned their attention to further improvements, and three years later, in the spring of 1925, produced another novelty in the form of the Lima 2-8-4, which was illustrated and described in Railway & Locomotive Engineering for May 1925.

The most striking novelty about this engine was the introduction of a four-wheeled trailer truck for carrying the firebox. The fact that it had four wheels was not the only novelty about it, for it introduced a truck whose frame was made to serve as a connecting drawbar link between the main frames of the locomotive and the tender. This made it possible to increase the width of the firebox by a foot and its length by 3 ft. With this added grate area the evaporative heating surface was raised to 5,110 sq. ft. or nearly 10 per cent. above the representative Mikado and nearly 12 above the preceding 8000. At the same time the superheating surface was raised to 2,111 sq. ft. or 81.5 per cent. above the representative Mikado and 18.59 per cent. above the 8000. At the same time the steam pressure was raised to 240 lbs. per sq. in., and the diameter of the boiler shell was increased to 88 in. or 2 in. more than the 8000, although it was, even then, 1 7/16 in. less than that of the representative Mikado. This slight increase in the diameter of the boiler shell with the great increase in the size of the firebox, with the addition of the four-wheeled truck, is responsible for the greater part of the 50,000 lbs. of additional weight that was put into the locomotive as compared with the 8000, although only 200 lbs. of the whole was added to the adhesive weight on the driving wheels. Another addition that has helped in the efficiency of the operation is the increase in the tender capacity from 10,000 to 15,000 gallons of water and from 16 to 18 tons of coal.

Like the 8000 the new locomotive is fitted with a booster.

These are the apparent changes, but another one was made that had a vital effect upon the coal economy to be taken up presently, and that was in the introduction of the limited maximum cut-off. In the two earlier locomotives, the usual arrangement of valve gear was used whereby, when the reverse lever was in full gear, the cut-off occurred at about 85 per cent. of the stroke. On this locomotive the limited maximum cut-off was introduced, with that point fixed at 60 per cent. of the stroke thus insuring an economical use of the steam expansively at all times.

It is to be noted that with an initial pressure of 240 lbs. per sq. in. and a cut-off at 60 per cent of the stroke, the mean effective pressure is almost exactly the same as that obtaining with an initial pressure of 210 lbs. per sq. in. and a cut-off at 85 per cent. of the stroke.

The effect of these improvements is shown by the table and the diagram. The tractive force of the engine was raised to 69,350 lbs. and, with the booster added, it was 82,800 lbs. or 3.97 and 6.56 per cent, above the corresponding conditions with the 8000. This gave an even greater and more favorable difference in drawbar pull, which was raised, at starting to 65,000 lbs. without and 76,850 lbs. with the booster's assistance. This amounted to 6.56 and 8.70 per cent. respectively over the corresponding conditions with the 8000.

These advantages are clearly shown by the lines of the diagram. Taking the indications at 10 miles an hour, as with the other engines, there was an engine drawbar pull of about 61,600 lbs. which became about 71,300 lbs, with the booster in operation or about 16.2 and 22.1 per cent, above the similar operating conditions of the No. 8000; while, when compared with the representative Mikado, the increases were 28.3 and 48.5 per cent. respectively; it being understood that the representative Mikado had no booster.

The booster was worked up to about 18 miles an hour, but with a decrease in output, as the speed increased that was more rapid than that of the locomotive.

At thirty miles an hour the drawbar pull was 40,000 lbs. or an increase of 28.6 and 63.6 per cent. over the 8000 and the representative Mikado respectively. While at a speed of 40 miles an hour the drawbar pull was the same as the representative Mikado at 25 and the 8000 at about 32 miles per hour.

As shown by the small diagram in the upper right hand corner the fuel economy kept pace with the other items.

DIMENSIONS		Representative Mikado Type (1922)	Lima Locomotive No. 8000	Lima A-1	Lima A-1 Per Cent Of Increase Over	
					Mikado Type	Lima 8000
Cylinder Diameter	in.	27	28	28	3.7	0
Piston Stroke	in.	30	30	30	0	0
Cut-Off in full gear	per cent of stroke	65	86	60	-29.4	-29.4
Weight on drivers	lbs.	246,000	248,000	248,200	6.94	.08
" " front truck	lbs.	26,500	29,000	36,500	33.96	22.41
" " trailing truck	lbs.	55,500	58,000	101,300	82.52	74.65
" total engine	lbs.	328,000	335,000	385,000	17.38	14.92
" tender	lbs.	187,600	200,300	275,000	46.59	37.29
Wheel base, driving		16 ft. 6 in.	16 ft. 6 in.	16 ft. 6 in.	0	0
" " total engine		36 ft. 1 in.	37 ft. 0 in.	41 ft. 8 in.	12.64	12.61
" " engine and tender		71 ft. 3 in.	71 ft. 6½ in.	82 ft. 6 in.	16.47	15.32
Wheels, diameter front truck	in.	33	33	33	0	0
" " driving	in.	63	63	63	0	0
" " trailing truck	in.	45	45	36 & 45	-26 & 0	-25 & 0
Steam Pressure	lbs. per sq. in.	200	210	240	20	14.29
Boiler, diameter first ring	in.	80 7/16	86	88	-1.6	2.33
Firebox, length	in.	114 1/8	114 1/8	150 1/8	31.54	31.54
" width	in.	75 1/4	84 1/4	96 1/4	27.91	14.24
Tubes, number		281		90		67.97
" diameter	in.	2		2 1/4		12.5
Superheater flues, number		45	253	204	353.33	-19.37
" " diameter	in.	5 3/8	3 1/4	3 1/2	-65.11	7.70
Length of tubes	ft.	21	20	20	4.76	0
Net gas area through tubes and flues	sq. in.	1285	1348	1535	2.74	22.00
Grate area	sq. ft.	59.6	66.4	100	67.79	50.60
Heating surface firebox including arch tubes	sq. ft.	250	291	337	34.80	12.37
" " tubes	sq. ft.	3090		1033	-65.86	
" " flues	sq. ft.	1310	4287	3718	183.80	-13.27
" " total evaporative	sq. ft.	4650	4578	5110	9.89	11.66
" " superheating	sq. ft.	1163	1780	2111	81.51	18.59
" " combined evap. and superheating	sq. ft.	5813	6358	7221	24.22	13.57
Tender, water capacity	gals.	10,000	10,000	15,000	30	50
" coal "	tons	16	16	18	12.50	12.50
Tractive effort, engine only	lbs.	59,000	66,700	69,350	17.54	3.97
" " engine and booster	lbs.		77,700	82,800		6.56
Drawbar pull, engine only	lbs.	51,150	61,000	65,000	27.08	6.56
" " engine and booster	lbs.		70,700	76,850		8.70
Weight on drivers ÷ total engine weight	Per cent	75	74.03	64.2	-14.40	13.28
" " " ÷ tractive effort		5.59	3.72	3.58	-35.96	-3.76
Total weight of engine ÷ combined heating surfaces		56.42	52.69	53.3	-5.53	1.16
Tractive effort ÷ combined heating surface		7.74	10.49	9.61	24.16	-8.39
" " X diameter drivers ÷ combined heat. surface		488	661	605	23.98	-8.47
Firebox heating surface ÷ grate area		4.19	4.38	3.37	-19.57	-23.06
" " " per cent of evap. heating surface		5.38	6.35	6.60	22.67	3.94
Superheating surface " " " " " "		25.01	38.88	41.40	65.53	6.48
Tube length ÷ inside diameter		126		107		-15.08
Combined heating surfaces ÷ grate area		97.53	95.60	72.2	-24.95	-24.48

Tabular Comparison of the Principal Dimensions and Other Details of Lima A1, Lima 8000 and a Representative Mikado of 1922

With a consumption of 5,000 lbs. per hour a drawbar horsepower of about 1,470 was developed. This was 51.5 per cent. more than the representative Mikado and 20 per cent. above the 8000.

With the coal consumption increased to 6,000 lbs. per hour the drawbar horsepower rose, on a slow drag movement, to 1,780 horsepower or 78 and 34.8 per cent. above the two engines respectively. Comparing the results of the two rates of firing on the engine itself we find that this increase of 20 per cent. in the amount of coal fired produced an increase of something more than 21 per cent. in the drawbar horsepower developed. A condition that was not even approached by either of the other two locomotives.

The diagram shows the lines of drawbar pull of the two earlier engines to be somewhat concave, with that of the 8000 straighter than that of its predecessor. In contrast to this is the line of the latest locomotive, which has been straightened out into a right line. This is due to two factors, increased boiler capacity and limited cut-off, the combination of which produces a drawbar pull speed curve as shown.

The accompanying table sets forth a comparison of the principal dimensions of the three locomotives. In the last two columns there is a comparison, on a percentage basis of the last development with its two predecessors. Among the notable comparisons is that of the ratio of tractive effort to the weight on the drivers, which was 5.59 on the earliest, and 3.58 on the latest of these three engines, or a difference of almost 36 per cent. Yet, with the reduction in the point of maximum cut-off, no trouble has been experienced with the slipping of the driving wheels.

At a meeting of the Mechanical Division of the American Railway Association in 1924, Mr. W. H. Winterrowd of the Lima Locomotive Works read a paper on "Engineering and Business Considerations of the Steam Locomotive." and which was published in the July 1924 issue of this paper. In one of his concluding paragraphs he said:

"The writer cannot close without some reference to the type of publicity that has been given from time to time to some of the various proposed substitutes for the modern steam locomotive. Railroad men cannot afford to deceive themselves regarding substitutes; neither should the public deceive itself. A substitute for the steam locomotive of the past is demanded not only by the exacting conditions of the present but by the still more exacting conditions inevitable in the future. The natural, sensible and logical substitute is the steam locomotive itself, improved in accordance with the knowledge, experience and vision that is now available."

When Mr. Winterrowd wrote this he undoubtedly had the Lima A-1 in mind, as it appeared soon afterwards. This notable locomotive has shown remarkable results in increased efficiency over its predecessors in keeping with his prophecy.

Rock Island Issues "Certificates of Mechanic"

College graduates are not the only persons who are entitled to diplomas in the opinion of W. J. Tollerton, General Superintendent of Motive Power of the Rock Island Lines, who today announced that the management of that railroad hereafter would issue "Certificates of Mechanic" to all shop apprentices who have completed their four years apprentice course in the Rock Island shops. These steel engraved certificates are considered a model of the printer's art and bear all the decorations to be found on many University diplomas.

These "diplomas" will bear the name of the graduate apprentice, the number of years he has served, the point of his employment and will be signed by the Superintendent of Motive Power and the Master Mechanic of the shops where the apprentice has completed his course.

In commenting upon the plan of the Rock Island to issue "diplomas" to its shop apprentices, Mr. Tollerton had this to say:

"It is our thought that each and every man completing an apprenticeship course will be very glad to have and keep something representative of this training the same as a university graduate takes pride in having and keeping his university diploma.

"Each man who has served an apprenticeship in our shops during the last three years will be furnished a 'Certificate of Mechanic,' as well as those who complete the apprenticeship course of training in the future."

The Influence of the Locomotive Upon the Unity of Our Country

Charles T. Main Prize Award Paper Presented to the American Society of Mechanical Engineers

By Clement R. Brown, Washington, D. C.

There are three things which make a nation great and prosperous: a fertile soil, busy workshops, and easy conveyance of men and commodities from place to place.—Lord Bacon.

Ever since the day of the *Stourbridge Lion,* the first locomotive to run in America, the locomotive has been one of the greatest factors in establishing unity in the United States. It is not necessary to recount here the quite familiar, yet very interesting, story of the invention and development of the locomotive. As to its introduction into America, however, it is well to remember the date, 1829, and the fact that the first locomotives built in America were not dominated by English ideas, as is often supposed. They were purely original developments of characteristic American ingenuity, and it was these locomotives that blazed the trail of civilization across the continent.

A study of the influence of the locomotive upon the unity of America can be conveniently divided according to three principal types of national unity. First, the locomotive has had a tremendous effect upon the history, political thought, and government of the United States. Second, its influence upon the industrial, commercial, and financial life of the nation is very great. Third, the social relations and ideas of the people and their language have been affected to a large extent by the locomotive. This paper will therefore be developed under the three types of unity, namely, political, economic, and social, all of which together constitute the unity of our country.

The influence of the locomotive in our national development can best be understood after a short outline of the development of the railroad system in America has been presented. The principal periods in American railroad history are:

1. *Experimental Period* (1830-1850). Railroads short and disconnected. Served principally as connections between waterways with no apparent objective.
2. *Trunk-Line Period* (*a*) From 1850 to Civil War. Trunk lines created, connecting Chicago and Mississippi with Atlantic. Much construction in old Northwest Territory and consequent network effect. (*b*) From Civil War to 1890. Transcontinental lines built, uniting East and West. Improvement of old lines.
3. *Period of Combination* (1890-). Great combinations formed. Government regulation. Great development. Better cooperation and organization.

In this manner the "railroad system" of the United States has been formed and unity has been developed in the railroad itself.

The Westward Progress of the Railroad

Buffalo from Albany	1842
Cincinnati from Lake Erie	1851
Chicago	1854
Mississippi River	1859
Missouri River	1859
Pacific Ocean	1869

Political Unity

The political unity of a nation is best measured by its transportation facilities. Its expansion, development, and its organization into a united nation depend to a large extent upon the ease of communication within its borders. Especially has this been true in America, for the locomotive has been the greatest single factor in shaping the history of this great nation. It first developed the settled seaboard and Middle West, then pushed the frontier westward to open up new territory and to add new states to the Union which it had preserved in its hour of need. The locomotive has influenced the shaping of national political thought and the formation of a strong national government, while it has been continuing its work so that now every community is united to every other community with ever-increasing bonds.

At the close of the first quarter of the nineteenth century there was no country in the world where the opportunity for benefits from transportation was so great as in America. The growing commercial cities of New England and the Atlantic States needed better transportation facilities. New states had been formed west of the mountains which demanded communication with the East. Beyond them stretched the vast Louisiana Territory of untold resources. The South, too, was expanding, and wanted inland connections with New England and the West. There was much enthusiasm for the building of canals and turnpikes, but withal, transportation facilities were very poor. Indeed, the East, South, and West threatened to be developed individually as separate national states. Such was the situation when the locomotive suddenly appeared on the horizon to solve the problem.

The first function of the locomotive in America was to provide easy and cheap transportation in territory already well settled. It united inland cities and towns with the seaports and brought the products of the fertile Ohio Valley across the mountains to the East, bringing manufactured goods in return. In performing this work the locomotive has further developed and organized the country. Especially was this true in the "Old Northwest" where the opportunity was greatest. Development of this nature was but little shared by the South until after 1880. With the formation of new states in the West this function has continued to be performed admirably by the railroads in developing national unity.

Gain in Population, East and West, from 1815 to 1860

	1815	1860
East	5,800,000	15,806,000
West	1,500,000	15,484,000

Railroad Mileage by 1860, East and South, and Northwest

East and South	19,506
"Old Northwest"	9,413

Note.—Mileage in the South increased from 20,600 in 1880 to over 50,000 in 1900.—Alexander Helper, op. cit.

A more important function of the locomotive, however, and one which is peculiar to America, is that of advancing the frontier and developing new territory into new states. This has been the chief task of the locomotive beyond the Mississippi. Here it is noticeable that the locomotive preceded the pioneer, as the pioneer preceded the immigrant. Lines of travel were "destined to be along parallels of latitude," and under the influence of the locomotive the frontier moved rapidly westward until, with the completion of the last transcontinental railroad in 1884, it suddenly disappeared forever. The tremendous resources of the Great Plains and the Far West had been opened up to the world, but the task of the locomotive was not finished. It now transformed this vast territory from a wilderness into a thriving land of cities, towns, and farms within less than a century. Its objective in this work has been the formation of new states. Probably the formation of none of the states east of the Mississippi can be accredited to the locomotive since most of them had been formed prior to its importance; but certainly many of the states west of the river owe their present existence directly to the locomotive.

Railroad Mileage by Sections of the Country, 1860-1890

Section	1860	1870	1880	1890
New England	3660	4494	5977	6832
Middle Atlantic	6353	10577	15147	20038
Central Northern	9583	14701	25109	36926
South Atlantic	5463	6481	8474	17301
Gulf and Mississippi States	3727	5106	6995	13343
Southwest	1162	4625	14085	32888
Northwest	655	5004	12347	27294
Pacific	23	1934	5128	12031

The influence of the locomotive upon the Civil War cannot be overlooked. It is no exaggeration to say that the locomotive preserved the Union. There was twice as much mileage of better-organized and better-equipped railroads in the North than in the South, which was of importance in the moving of troops, ammunition, and food. The factor of most importance, however, was completed before the war. During the decade preceding the struggle the locomotive had united the people of the Ohio Valley with those along the Great Lakes, and these in turn with those of the East, an accomplishment destined to be the deciding factor in the coming crisis. Thus the locomotive was of great aid in winning the war and in preserving that Union to which it has since added many states.

Not only has the locomotive created a large and populous nation, but it has united the people of that nation with ever-increasing bonds. It is eradicating sectionalism in political thought and is making Americans of all. It has been very influential in making our government national in character. In fact, it makes representative government successful because it permits extensive personal political campaigns and easy communication between the representative and his constituents.

Population and Railway Mileage in 1860

	Population	Mileage
North	20,310,000	20,274
South	11,133,000	10,352

The locomotive has had a tremendous influence upon the political unity of America. It has been seen how the locomotive has developed America into a united nation, an accomplishment which would have required centuries without its influence, and which never could have been accomplished so thoroughly. The test of its work came with the World War, which found America united and ready, and its railroads able to play an important part when acting as a single unit. The locomotive was unquestionably proven, but its work was not finished, for it is still continuing to establish further unity in our country.

Economic Unity

The locomotive has brought economic unity to the United States. The nation is not made up of many isolated areas, with no economic connections between them. Instead, under the influence of the locomotive, America's great natural resources have been developed and her products have been distributed over the entire land, so that a well-organized economic system now exists.

The presence of remarkable natural resources in America is well known and transportation facilities have formed the basis of their development. "This is preeminently and primarily an agricultural country." In the development of its agricultural resources the locomotive has played an important part, especially in the opening up of the grain lands of the Ohio and the Mississippi and the grazing lands of the Great Plains and the Southwest. America has rich mineral deposits, but it is the locomotive that makes their extraction profitable. The enormous production of the ores of Lake Superior and the Rockies, the coal of the Alleghanies, and the oil of Oklahoma is due in a large measure to cheap transportation. Timber is another important resource of the United States, and the locomotive has been a vital factor in developing the lumber industry of both the Old Northwest and the New Northwest, as well as that of the South. These are but a few of the many natural resources of America, all of which owe much of their development to the locomotive.

It is in the field of transportation that the locomotive has had its greatest influence upon the economic unity of our country. Easy and cheap transportation has increased the area of production of every commodity so that it can now be produced profitably at a great distance from the market as well as near-by. It facilitates the gathering together of the raw materials from all parts of the country to the centers of distribution and manufacture. Modern transportation permits the localization of industry near the source of supply or at points best suited for the manufacture of a particular article. The locomotive has widened the market of every commodity produced in the land, and serves, by encouraging competition, to distribute the products to every community of the nation.

In the development of our natural resources and the creation of industry, the locomotive has created commerce in the United States. Commercial centers have been created and developed at centers of distribution, such as railroad centers, and at points of change from one means of transportation to another, such as seaports. By its very nature, railroad development encourages development in other means of transportation. Thus the commerce of America has been built up until it has reached tremendous proportions, and the locomotive has been one of the greatest factors in its development.

Labor is needed in commerce and industry and the locomotive is a vital factor in supplying the demand for it. It permits a wide distribution of labor and supplies easy and quick transportation of labor from place to place as needed. It also supplies a market for various kinds of labor. The locomotive has facilitated immigration by transporting the immigrant to new lands where his labor is most needed. It is noticeable that the number of immigrants increased tremendously with the advent of the railroad. The locomotive has helped to make the standards and conditions of labor uniform throughout the country. In this manner labor has become a united force to serve the nation's industries.

Another field of economic importance in which the influence of the locomotive has been felt is that of finance. The locomotive has not only created and developed wealth, but it has also influenced its distribution. The development of corporations for financing large-scale operations came with the locomotive. It also aids in the distribution of money and facilitates its movement from place to place, thus tending to prevent panics. It enables business enterprises to operate over a vast territory with ease. The railroads themselves form a very significant part of the total wealth of the nation, of which the locomotive has been an important factor in developing.

"The effects of railroad construction are far-reaching." It is hard to overestimate the influence of the locomotive upon the development of our natural resources, industry, commerce, labor, and finances into a well-organized economic system. Certainly it may be said that this, the economic unity of America, owes much to the locomotive.

Social Unity

The locomotive has been very influential in the development of social unity in America. In fact, the history of the locomotive is closely allied with the modern development of civilization. Better communication has brought better understanding and knowledge between peoples and is doing away with sectionalism in social thought and placing national social unity in its stead. The locomotive is of great aid in relieving suffering in time of distress. Modern travel has become a pleasure in itself. All these tend toward national peace, prosperity, and happiness, and in this the locomotive is an important factor.

Modern civilization has advanced farthest in those places where the locomotive is seen most often. The locomotive is its keynote, for it introduces modern art into the community. It encourages religion, education, and good government, while it is noticeable that bigotry, illiteracy, and lawlessness are found where railroads are not. The locomotive promotes progress in civilization among the people.

Better communication as afforded by the locomotive has several effects beneficial to a greater social unity in our country. The locomotive enables peoples of different communities to become better acquainted with one another. The customs and manners of one become better known and understood by the other. One of the greatest means of accomplishing this end is the "convention," which itself has been made possible to a great extent by the locomotive. Every year thousands of people are gathered together from all parts of the country in various places. Although various fields of endeavor are represented and many ideas are exchanged, it is the social contact at these conventions that does the most to promote a better understanding between peoples and communities.

Not only does better communication encourage better knowledge of society, but it tends to unite society in America with national bonds. Through better acquaintance, ideas, customs and manners, and views on common problems are exchanged, with the result that national ideas, national customs and manners, and national views are developed. Religion, education, and government become national in character. The locomotive is preventing and eradicating the growth of dialects in America and is thus establishing a common language. Because it is the mail carrier of the nation and sends and brings the messages of the people, the locomotive provides a cheap form of communication which is an important factor in the development of social unity. The nation is united even in its emotions, for the mourning of the death of a president is as spontaneous as the celebration of the announcement of peace.

The locomotive is of great aid in times of distress. A flood on the Ohio, a tornado in Kansas, a fire in Chicago, or an earthquake in San Francisco, and the locomotive immediately rushes aid from all parts of the country to the distressed sufferers. A famine in any locality is nowadays almost impossible, for the locomotive soon relieves a shortage in any commodity, no matter what the season may be.

Modern conveniences have added to the work of the locomotive to make modern travel a pleasure. One is now able to visit all parts of the country with ease and comfort, and at little expense. By this means the locomotive enables the citizen to obtain a broader knowledge of his native land and at the same time to enjoy her beauties. Thus the locomotive is not only able to relieve man of his sorrow, but it has added new pleasures to increase his contentments in America.

No country in the world is as prosperous as America. Its people have an abundance of food, clothes, and wealth, and comfortable homes in which to live. They are happy and peace reigns among them. The locomotive has had a tremendous influence in bringing prosperity and contentment to America. Truly, as James J. Hill has said, "The railway, next after the Christian religion and the public school, has been the largest single contributing factor to the welfare and happiness of the people."

Modern transportation is a great benefit to society. It develops its civilization, increases its scope, knits it together more firmly, relieves its sorrows, and adds new pleasures for its enjoyment. It promotes prosperity and contentment among its members. The locomotive, which has made cheap and easy communication possible, has thus been a vital factor in establishing social unity in America.

Conclusion

It is a century and a half since the Union had its humble, yet determined beginning. With less than a century of existence the locomotive has had a tremendous influence in the accomplishment of a great and unparalleled achievement. Not only has the Union been increased, the national domain extended, and the population multiplied many times, but the nation has wealth and her people are prosperous and contented. But above all, the locomotive has given political, economic, and social unity to America. It is recognized, however, that these three types of unity are by no means entirely separable. In fact, they are quite inseparable, for each one is involved in the other two to a great extent, and it is only when taken together that they make up the unity of our country.

Today a network of railroads covers the United States. Every community is united to every other community with bonds of steel. As to the future, the locomotive can be confident of more than holding its place in transportation. No other means of transportation can compare with the locomotive in efficiently supplying cheap and quick transportation of goods and men wherever needed. Just as past experience has shown the locomotive to exceed all expectations, so for the future it is safe to say that the locomotive will continue to be of the greatest influence in preserving the unity of our country.

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Heavy Electric Traction

At the recent meeting of the American Electric Railway Association a committee report was presented whose special interest lay in a series of tables illustrating and describing the heavy traction locomotives in use throughout the world.

In discussing the branch line operation of steam railroads, some data were given regarding the efficiency and cost of operation of motor cars. It said that in general the cost of operation of motor cars is below that of steam engine trains in branch line service, and both the character of the service and the running time may be improved. The cost of repairs of gas motor cars may be open to some question owing to the small mileage made thus far with such equipment. In this connection, it is instructive to note the record of nine gas-electric cars making a total of 566,508 miles in twenty-four months' operation (July 1, 1922, to June 30, 1924), on the St. Louis & San Francisco Ry., prior to which time the cars had been in regular service for several years. This is an average of 2,623 miles per month for each car for the whole period.

The following table shows the comparative operating data of gas-electric cars operated by a crew of two men on the St. Louis & San Francisco with similar data upon a typical branch line operated by steam engines, hauling trains of two and three passenger cars and manned by the usual complement of engineer, fireman, conductor, baggageman and brakeman. This gives a general perspective of the field of usefulness of the gas-electric car in this class of service.

St. Louis and San Francisco Railway
Operating Expenses, 9 Gas Electric Cars
July 1, 1922—June 30, 1924
(Cars built in 1911)

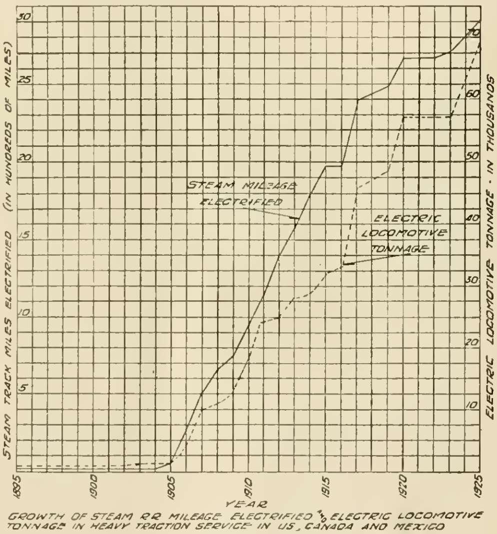
	Gas Elec.	Typical Steam Train
Total motor car miles	566,508	......
Total trailer car miles	256,018	......
Total car miles	822,526	......
Wages per train mile	17.67c.	28.80c.
Fuel and lubricants	8.78c.	18.60c.
Running repairs	3.01c.	} ......
Classified repairs	4.68c.	} 31.40c.
Miscellaneous and supplies	.67c.	4.50c.
Total expense per train mile	34.81c.	83.30c.
Total expense per car mile	24.00c.	......

The gas-electric cars operating upon the St. Louis & San Francisco Railway have a weight of 104,000 lb., 70-ft. body, 11-ft. baggage space, 8 cylinder gas engine, 8 in. x 10 in., running at 550 r.p.m., and two 110 h.p. motors. Approximately 100 of these cars have been built and put into operation on various lines, but manufacture was discontinued during the war due to expediency and also the high weight and price of the equipped car. While the lighter and less expensive cars now sold are expected to supersede the heavier gas-electric cars previously built, it is instructive, nevertheless, to note the reasonable cost of operating the older equipment after it had been in operation a sufficient term of years to reach what might be accepted as stable maintenance expense.

Motor cars which will be equipped with semi-Diesel oil engines are now in construction, but no adequate operating data is available.

The electric storage battery motor car has a field of usefulness under certain conditions which must include the acceptance of excess car weight, an electric power supply, and a high maintenance and depreciation expense due to the limitations of the storage battery.

An interesting diagram is given in the appendix, which is here reproduced, showing the steam railroad mileage



Curve Showing Growth of Electric Locomotive Tonnage and Steam Mileage Electrified

that has been electrified annually for the thirty years from 1895 to 1925. According to this diagram there was no increase of electrification from 1895 to 1904. During the following year about 40 miles were electrified. Then there was a sudden jump ahead, and from 1905 to 1917 the mileage of electrified steam lines rose from 50 to 2,400 miles, or at the rate of nearly 200 miles a year. Since that time the annual increment of advance has been less, with the total now standing at 3,000 miles.

The electric locomotive tonnage has followed the same general upward trend, but with more variations in rate. For example, it was stationary from 1920 to 1923, but during the past two years it has been rising rapidly.

As already stated, the outstanding feature of the report, and the portion involving a great amount of work is that of the three tabulations of heavy electric locomotives throughout the world. These tables cover, respectively, the alternating current locomotives, the direct current locomotives and the multiple train units engaged in heavy traffic.

COUNTRY	RAILWAY	Volts	Number	Weights in Pounds			
				Maximum		Minimum	
				Total	Driving	Total	Driving
Argentine	Buenos Aires & Western	800	2	147,400	147,400	147,400	147,400
Brazil	Paulista	3000	28	283,000	206,000	122,300	122,300
Canada	Canadian National	2400	10	200,000	200,000	166,000	166,000
Chile	Bethlehem - Chile	1200 & 2400	3	239,000	239,000	239,000	239,000
"	Chilean State	3000	39	259,800	210,000	137,000	137,000
Mexico	Mexican	3000	10	308,000	308,000	308,000	308,000
United States	Baltimore & Ohio	600	13	242,700	242,700	160,000	160,000
" "	Butte Anaconda & Pacific	2400	28	162,000	162,000	161,000	161,000
" "	Chicago Milwaukee & St.Paul	3000	103	600,000	378,000	143,000	143,000
" "	Long Island	650	1	175,800	175,800	175,800	175,800
" "	Michigan Central	600	10	240,000	240,000	200,000	200,000
" "	New York Central	600	82	262,900	262,900	200,000	200,000
" "	Pennsylvania	600	36	408,600	308,600	195,100	195,100
England	Northeastern	1500	11	228,500	166,000	167,000	167,000
"	Metropolitan	600	20	123,500	123,000	123,500	123,000
France	Midi	1500	101	224,000	119,000	158,000	158,000
"	Paris & Orleans	600 & 1500	210	256,000	158,000	149,000	149,000
"	Paris Lyons & Mediterranean	1500	34	344,000	158,400	250,000	211,400
"	State	600	30	135,000	135,000	135,000	135,000
Italy	Italian State (Milan-Varese)	600	10	152,000	105,600	152,000	105,600
Spain	El Norte	3000	12	185,000		179,000	179,000
Japan	Imperial Government	1500	51	214,000	161,000	121,000	121,000
Java	Netherlands East Indies State	1500	6	170,000		110,000	
Australia	Victorian Government	1500	2	111,000	111,000	111,000	111,000
"	Western Australian Government	600	1	107,500	107,500	107,500	107,500
New Zealand	Midland	1500	5	107,400	107,400	107,400	107,400
South Africa	South African	3000	78	146,700	146,700	146,700	146,700

Direct Current Electric Locomotives of Different Countries, Their Number and Weights

The following table, abstracted from the table of the report, gives the number of such locomotives with their average, maxima and minima weights. The report also gives diagrams of all of the wheel bases used and these seem to cover every possible combination. There are direct connected units, such as 2—8—2+2—8—2 and motors driving through intermediate jackshafts with 2—6+6—2 and 4—8—2 arrangements. There is, however, a far greater diversity of wheel base arrangements among the locomotives using the alternating current than among those using direct. Among the latter the direct connection between the motor and the axle is the usual drive, though there are a few examples of the use of the intermediate jackshaft, and some of a rod connection between the armature shaft and the driving wheels. The diameters of the driving wheels range from 39.4 inches to 80 inches; the former being on the 1,340 and 1,550 horsepower locomotives of El Norte Ry. of Spain, using direct current with direct connected motors, and the latter on the 3,070 horsepower locomotives of the Pennsylvania R. R., using the single phase alternating current and having a jackshaft interposed between the motors and the driving wheels.

There is the same or even wider variation in the speeds at continuous ratings. These range from 11.4 to 74.6 miles per hour. The former being that of the New York, New Haven & Hartford 2—8—2 switching locomotive of 440 horsepower and the latter that of the Oranienburg, Germany, 4—4—2 express locomotive of 828 horsepower. The high speed of German locomotive is followed very closely by the New York, New Haven & Hartford 2—8—2 engine with a continuous rating of 1,016 horsepower at a speed of 73 miles an hour. All of these engines use the single phase alternating current.

The extreme in differences is reached in the variations in the weights of the locomotive per horsepower developed. This runs from 37 lb. on the 2—8—2 passenger locomotive of the Italian State Ry. that develops 3,280 horsepower on a one-hour rating using a three-phase alternating current, to 394 lb. per horsepower on the Great Northern 2—8—2+2—8—2 locomotive that is rated at 1,725 horsepower for continuous running and at 2,000 for one hour using the single phase alternating current. The total weight of the Great Northern locomotive is 680,000 lb. and that of the Italian State Ry. is 196,000, or something less than one-third as much .

COUNTRY	RAILWAY	Phase	Number	Weights in Pounds			
				Maximum		Minimum	
				Total	Drivers	Total	Drivers
Canada	Grand Trunk	Single	6	132,000	132,000	132,000	132,000
United States	Boston & Maine	"	7	265,500	217,000	260,000	204,000
" "	Detroit & Ironton	"	2	340,000	340,000	340,000	340,000
" "	Great Northern	"	8	680,000	520,000	230,000	230,000
" "	New York New Haven & Hartford	"	125	358,000	240,000	158,000	158,000
" "	Norfolk & Western	"	32	414,000	298,000	302,200	256,400
" "	Pennsylvania	"	2	516,000	439,500	408,600	308,600
" "	Virginian	"	36	430,000	315,000	426,000	
Austria	Mariazell	"	14	104,000	104,000	104,000	104,000
"	Mittenwald	"	12	117,000	117,000	92,700	92,700
"	Vienna - Pressburg	"	8	118,000	61,800	118,000	61,800
"	Austrian State	"	51	250,000	192,000	148,000	96,000
"	Murnau	"	2	52,800	52,800	44,100	44,100
"	Oranienburg	"	1	131,200	99,200	131,200	99,200
Germany	German State	"	303	277,000	160,000	123,600	123,600
Norway	State	"	30	298,000	227,000	134,500	134,500
Sweden	Nordmark	"	15	90,800	56,800	90,800	56,800
"	State	"	99	280,000	222,000	149,500	149,500
Switzerland	Loetschberg	"	31	236,000	136,500	151,000	112,500
"	Rhaetian	"	27	145,000	145,000	80,600	48,000
"	Swiss Federal	"	277	297,700	252,000	108,000	89,000
"	Simplon Tunnel	Three	6	195,000	153,000	138,000	100,000
Italy	Italian State	"	294	202,800	109,100	101,400	101,400

Number and Weights of Alternating Current Electric Locomotives of Different Countries

From the accompanying tables it will be seen that there are, in the United States and Canada, 218 locomotives using alternating current and 283 using direct current. In Europe there are 873 locomotives using single-phase and 500 using three-phase alternating current and 419 using direct current. There are no alternating current locomotives in use elsewhere than in the United States, Canada and on the continent of Europe. In Mexico and South America there are 82 direct current locomotives. In Europe there are 428 and in the rest of the world 143, making a grand total of 1,591 alternating current and 1,355 direct current or 2,946 electric locomotives in the world.

The weights of these locomotives range from a total of 44,100 lb. with the whole weight on the drivers of the Murnan Ry. of Austria to a total of 680,000 lb. with 520,000 lb. on the drivers of the Great Northern. The nearest approach to this is that of the Chicago, Milwaukee & St. Paul locomotive having a total weight of 600,000 lb., of which 378,000 lb. are upon the driving wheels. No report is given of any multiple unit trains outside of the United States and Canada. In Canada there is but one road, the Canadian National, operating multiple unit trains. This road has but eight cars in service, and these are on the Mt. Royal line out of Montreal. Outside of this one example the remainder reported upon are in the United States. Here there are 9,662 cars, scattered over seventeen roads with the Interborough leading with 3,093 cars. Of these roads six are strictly urban roads. These are those of Boston, Brooklyn, Chicago, Hudson & Manhattan, Interborough of New York, and Philadelphia, the rest are engaged in interurban work. This may also include the Hudson & Manhattan.

The seating capacity ranges from 116 on the Southern Pacific to 38 on the Chicago Rapid Transit, though for purely interurban work the smallest cars are those of the New York Central, which seat 42 passengers. The Illinois Central has two types of cars, the motor indicated by M in the table and the trailer indicated by T, each of which have a seating capacity of 84.

The original tables of the report are very complete and give voltage and frequency of the alternating currents, which is 16 2-3 on some of the German, Swiss and Italian lines. A frequency of 15 is also used in Sweden, Switzerland and Italy. There are two cases of 45 in Italy. Throughout the United States and Canada, with two minor lines abroad, a frequency of 25 cycles is the standard.

The headings of the report tables also include the gauges; the years in service; number of units; type of service; an axle classification; type of drive; wheel diameters; length over all and wheel base; total weights and weights and drivers, and of the mechanical and electrical parts and bodies; the one-hour and continuous rating in horsepower and speed, with the weight per horsepower for each rating; the maximum speed; the number, type and gear ratio of the motors; the number of transformers; diagrams of the wheel and cab arrangements and the names of the manufacturers of the mechanical and electrical parts. In short, a very complete and detailed statement of all of these locomotives.

MULTIPLE UNIT TRAINS OF NORTH AMERICA

RAILWAY	Number	Volts	Current	Total Weight Lbs.		Seating Capacity	
				Maximum	Minimum	Maximum	Minimum
Boston Elevated	534	600	D. C.	86,400	46,000	72	42
Brooklyn-Manhattan Transit	1550	600	"	94,080	67,000	90	53
Canadian National	8	2400	"	120,000	120,000	68	68
Chicago Rapid Transit	1177	600	"	76,650	52,714	52	38
Chicago, North Shore & Milwaukee	96	600	"	93,000	67,000	56	46
Erie	8	11,000	A. C.	117,000	98,000		
Hudson & Manhattan	361	600	D. C.	74,550	69,620	44	44
Illinois Central	130	1500	"	133,940M	98,300T	84	84
Interborough Rapid Transit	3093	600	"	49,720	28,000	48	46
Long Island	682	600	"	129,650	76,444	72	32*
New York Central	285	600	"	132,200	107,500	82	42
New York New Haven & Hartford	46	11000 & 600	A.C.-D.C.	176,000	139,700	76	76
New York, Westchester & Boston	50	11,000	A. C.	120,000	120,000	78	78
Pennsylvania	138	11,000	"	121,600	113,600	72	52
Philadelphia Rapid Transit	323	600	D. C.	86,000	70,000	51	48
Southern Pacific	91	1200	"	114,000	109,400	116	116
Staten Island Rapid Transit	90	600	"	96,700	96,700	71	71
West Jersey & Seashore	108	675	"	106,000	80,000	72	58

*Combined Passenger and Baggage

Details of Multiple Unit Trains of North America

Chilean Mining Properties to Electrify Haulage Systems

The Andes Copper Company at Potrerillos, Chile, and the Chile Exploration Company at Chuquicamata, Chile, have just placed with the Westinghouse Electric and Manufacturing Company orders totalling 23 industrial electric locomotives for the purpose of inaugurating the electrification of the haulage systems at these two mining properties.

The order received from the Andes Copper Company calls for eight 10-ton trolley type locomotives and two 15-ton battery type locomotives, all of these units having modern contactor control. The Chile Exploration Company has ordered six 70-ton combination trolley and battery type locomotives, three 25-ton pusher type locomotives including substation equipment and switch gear, and four small battery locomotives. All of these locomotives are to be built jointly by the Westinghouse company and the Baldwin Locomotive Works.

The Chile Exploration Company has been considering this electrification for several years, and the present equipment represents the initial step in this important installation. The complete electrification eventually will require some 50 additional 70-ton locomotives, these units to be used in moving cars of copper ore from the electric shovels at the mine to the mill and in general haulage around the plant. These large locomotives are the first ones of the combination type to be built with articulated or connected trucks, this construction hitherto used only on the powerful railroad locomotives. Power at 600 volts direct current is furnished to the locomotives by a third rail system and when the locomotive reaches the end of the third rail the shoe used to collect the current is automatically picked up and the locomotive propelled by current drawn from the storage batteries it carries.

The smaller pusher locomotives are designed to run on a narrow gauge track alongside of the tracks upon which the ore cars are operated. An arm on the pusher locomotive may be swung behind a car on the adjacent track and the car "spotted" for unloading at any desired place. This does away with the necessity of moving an entire train of cars in order to move any particular car to a certain location.

The electric power for this haulage system at Chile Exploration Company is generated by steam turbines and oil fired boilers located at the seacoast at Tocopilla, 75 miles away, and transmitted to the mining property at 110,000 volts.

Both of these mines are the property of the Anaconda Copper Company. The Andes Copper Company at Potrerillos is a new development while the Chile Exploration Company at Chuquicamata is an old established producer, and is one of the largest copper mines in the world.

I. C. C. Issues Annual Report for the Year 1925

The Interstate Commerce Commission has just issued its thirty-ninth annual report to Congress, covering the period from November 1, 1924, to October 31, 1925. All phases of the Commission's activities and transportation developments of the past year are described in detail. Among the major subjects dealt with in the report are earnings, consolidation of railroads, valuation, recovery of excess earnings, freight congestion in Florida, freight movement, and casualties. In reporting on these subjects the Commission says, in part:

The volume of passenger traffic expressed in the number of passengers carried 1 mile in 1924 was 36,375 millions, compared with 38,294 millions in 1923, a reduction of 5.01 per cent.

There has been a gradual increase in the average journey per passenger since 1915, which in that year was 32.95 miles; in 1917 it was 36.13 miles; in 1920, 37.30 miles; in 1923, 37.97 miles; and in 1924, 38.25. The great increase in travel by automobile, especially for short distances, doubtless accounts for this to a large extent.

The number of Pullman passengers was 39.2 millions in 1920 and 34.1 millions in 1924, a decline of 13.2 per cent. In 1920 Pullman revenues were equal to 5.68 per cent of the railroad passenger revenue, as compared with 6.87 per cent in 1924.

In the year 1923 the highest record of freight traffic volume for any one year thus far was made, 1,387,754,966 tons of freight having originated on steam railways in the United States. In the year 1924, the corresponding record shows a decrease of over 99 millions of tons, or 7.16 per cent, the amount for the latter year being 1,288,357,339 tons. Expressed in ton-miles, the revenue freight traffic volume in 1923 amounted to 416,256 millions, and in 1924 to 391,981 millions, a decrease of 5.83 per cent.

In the first seven months of 1925 the number of tons of freight carried on Class I steam railways exceeded that for the corresponding period of 1924 by 5.75 per cent, but was less than the tonnage carried during the corresponding period of 1923 by 5.24 per cent.

The average length of haul of a ton of freight in 1924, treating all of the roads of the United States as one system, was 304.25 miles, as against 299.94 miles in 1923, and 308.60 miles in 1919, the last-mentioned average being the highest on record. For the fiscal year 1915 the average haul was only 270.69 miles. These variations reflect effects of changes in the course of productive and commercial activities.

Earnings

The total railway operating revenues of Class I steam railways, excluding switching and terminal companies, for the calendar year 1924 amounted to $5,921,490,100 as against $6,289,580,027 for 1923, a decrease of more than $368,000,000, or 5.85 per cent, in 1924 compared with the preceding year. Operating expenses for 1924 amounted to $4,507,845,037 as against $4,895,166,819 for 1923, a decrease of 7.91 per cent. Net railway operating income in 1924 was $973,870,978 and in 1923 $961,955,457, an increase of 1.24 per cent. The operating ratio for 1924 was 76.13, which was 1.70 less than for 1923.

The largest amount of net railway operating income ever earned by our steam railways in a calendar year was in 1916, when, for the class above stated, the amount was $1,040,084,517. This was $66,213,539 more than in 1924, a difference of 6.37 per cent in favor of the record year. The operating ratio in 1916 was 65.54 as against 76.13 in 1924.

A partial explanation of these different results nearly a decade apart is that in 1916 the proportion of revenues going into the pay roll of these roads was 40.8 per cent whereas in 1924 it was 47.7 per cent. The increase in costs of material and supplies and other expenses, and an increase of taxes, generally account for the remainder.

Under "Fair Return"

Railway tax accruals, in 1924, amounted to $342,459,598, an increase of 2.83 per cent over 1923. In 1916 they amounted to $163,450,852. The steam railway tax bill in 1924 was thus 109.52 per cent higher than in 1916.

In our last report we said of the preceding calendar year:

"As the annual net railway operating income has been recently less than $1,000,000,000 it is safe to say that the return of 5¾ per cent upon fair value is not being received by the carriers."

Large additions have been made to capital account for improved facilities and equipment since that report was written, and the net railway operating income for 1924 was $973,870,978, or only 1.24 per cent more than for 1923.

The net railway operating income for the eight months ended with August, 1925, was $651,883,260; that for the corresponding period of 1924 was $554,886,471, while for a like period in 1923, the calendar year of largest total revenues and heaviest volume of traffic, this item was $618,964,978.

Therefore, for that part of the current calendar year for which data are available at the time this report is written, increases of 17.48 per cent over the corresponding period of 1924 and of 5.32 per cent over the same for 1923 are shown. These better results have been largely accomplished by the lowering of the operating ratio, which for the eight months' period of 1925 was 75.81 as compared with 78.12 for 1924 and 78.38 for 1923.

Recapture of Excess

During the year 33 carriers paid to us the total sum of $732,448.34 on account of one-half of their excess incomes as preliminarily computed for the various recapture periods. This sum added to the $4,955,197.27 paid prior to November 1, 1924, makes the total of such payments $5,687,645.61. As the bulk of these payments has been made under formal protests and reservations, the general railroad contingent fund, composed principally of such payments, has not been available for the purposes contemplated by the statute.

The present status of the fund is as follows:

Payments by carriers of excess income....	$5,687,645.61
Payments by carriers of interest on overdue payments	19,879.47
Interest from bank balances	2,062.30
Interest from investments in obligations of the United States	231,751.76
Total credits to the general railroad contingent fund	$5,941,339.14

Consolidations

In our last report it was noted that the work of preparing the complete plan of consolidation was progressing. On February 4, 1925, we addressed a letter to the chairman of the Senate Committee on Interstate Commerce, in which the majority of the Commission expressed doubt as to the wisdom of the provisions of the law which now require us to adopt a complete plan to which all future consolidations must conform. They further stated that they had been impelled to the belief that results as good, and perhaps better, are likely to be accomplished with less loss of time if the process of consolidation is permitted to develop, under the guidance of the Commission, in a more normal way. A proposed amendment to section 5 of the interstate commerce act was attached to the letter.

The following explanation of the proposed amendment is quoted from the letter:

Briefly the amendment would accomplish the following results:

(1) Relieve the Commission from its present duty of adopting a complete plan of consolidation.

(2) Make unlawful any consolidation or acquisition of the control of one carrier by another in any manner whatsoever, except with the specific approval and authorization of the Commission. . . .

Employment

The average number of persons employed by Class I steam railways, excluding switching and terminal companies, during the year 1924 was 1,751,324, and the total compensation amounted to $2,826,025,230, which was 62.69 per cent of the total railway operating expenses of that class of roads for the year. The total number of employes of such roads at the middle of July, 1925, was 1,795,669.

Accidents

The statements tabulated from monthly reports of railway accidents, submitted by carriers in compliance with the accident reports act of May 6, 1910, indicate that in the year 1924 there were 6,617 persons killed and 143,739 injured in reportable accidents of all kinds on steam railways. These figures include 402 fatal and 95,368 non-fatal injuries resulting from non-train and industrial railway accidents. The number of locomotive-miles run in 1924 was 4.8 per cent less than in 1923, while the number of casualties resulting from train operation was 13.9 per cent less.

Fatalities in grade-crossing accidents in 1924 were 2,149 or 119 less than in the previous year. There were, however 6,525 non-fatal injuries in accidents of this kind or 211 more than in 1923.

In both years automobiles were involved in accidents that caused 84 per cent of the total casualties at crossings. Automobile registration for 1924, 17,591,981, was 2,499,804 more than in 1923. Accident statistics have been furnished railway officials, insurance companies, manufacturing concerns, the National Safety Council, and other organizations interested in accident prevention.

Casualties Decrease

The casualties on steam railroads in connection with the operation of trains during the calendar year 1924 are summarized as follows:

Class of persons	Number of persons Killed	Injured
Trespassers	2,556	2,853
Employes	1,246	32,401
Passengers	149	5,354
Persons carried under contract, such as mail clerks, Pullman conductors, etc.	20	557
Other non-trespassers	2,244	7,206
Total	6,215	48,371

The corresponding totals for the calendar year 1923 were 6,922 persons killed and 56,464 persons injured.

In addition, there were 402 persons killed and 95,368 injured in non-train accidents in comparison with 463 killed and 115,248 injured in such accidents during the preceding calendar year.

There were 72 employes killed and 1,592 injured in coupling or uncoupling locomotives and cars as compared with 103 killed and 1,954 injured during 1923. Casualties to employes due to coming into contact with fixed structures resulted in 36 killed and 733 injured. There were 67 employes killed and 6,625 injured in getting on or off cars and locomotives.

Tain-Control Devices

As stated in our last report we adopted in June, 1922, specifications and requirements for the installation ot automatic train-stop or train-control devices, and by order served on 49 carriers directed each to install by January 1, 1925, upon a full passenger-locomotive division, included within a designated portion of its lines, a device in accordance with these requirements. This order of June, 1922, is commonly referred to as the first order.

In January, 1924, we adopted and served a second order requiring 47 of the original 49 carriers each to install such a device upon a second full passenger-locomotive division, and each of 45 additional carriers to install such a device on one full passenger-locomotive division within designated limits upon its lines by February 1, 1926.

Under the order of June, 1922, all carriers to November 1, 1925:

Total road miles to be equipped	4,449.6
Total road miles equipped	2,617.4
Balance to be equipped, road miles	1,832.2
Total number of locos. to be equipped	3,858
Total number of locos. equipped	1,323
Balance of locos. to be equipped	2,535
Per cent of total road miles equipped	58.8
Per cent of total locos. equipped	34.3

Valuation

Tentative valuation reports have been issued on more than half of the carriers and mileage. Work on the remaining carriers and mileage is well advanced.

Hearings on protests against tentative valuations were concluded during the year in 62 cases, embracing 25,784 miles of road, or 10.6 per cent of the total mileage, bringing the total number of cases in which hearings have been completed up to 212, covering 43,600 miles or 17.9 per cent of the total. Sixty-four cases representing 26,469 miles, have been partly heard.

During the year 53 final value reports, covering 4,929 miles of road, were issued, the total number of reports and miles being thus brought to 88 and 9,325 or 3.8 per cent of the total mileage. In addition, 86 tentative valuation reports covering 1,733 miles of road have become final through lack of protest. The total number of such cases is now 225 and the mileage 5,379, being 2.2 per cent of the total mileage. In 30 such cases, covering 1,282 miles of road, we have issued formal reports declaring the valuations final by operation of law, and these are included in the 88 cases above shown. Reports are now final on 5.5 per cent of the entire mileage of the country.

Congestion in Florida

This is the most serious situation with respect to congested traffic that has confronted us during the year. The line principally involved is the Florida East Coast Railway. Complaints from many sources, including the Governor of Florida and the Florida Railroad Commission, were received by us with respect to the failure of carriers to accept and move traffic currently.

The unprecedented activity in Florida has rendered inadequate the facilities of the carriers in that State and the continuously increasing amount of business throughout the summer, which under normal conditions is the period of business inactivity, seriously interfered with the double tracking, yard, and terminal extensions, and other improvement programs which the Florida East Coast Railway has under way.

Service agents were sent to Florida to keep in touch with the situation, to work cooperatively with carriers and shippers, and to devise ways and means for minimizing particular hardships. The reduced operating efficiency due to the clogged condition of terminals and sidings was attributable in part to the failure of consignees to unload cars promptly. We solicited the support of municipal authorities and civic organizations, with the result that many of the communities made concerted drives to release cars.

We also urged the carriers connecting with the Florida East Coast to pre-classify cars in so far as possible prior to delivery to it, so as to avoid delays at terminals and facilitate the movement. Splendid cooperation was afforded, but we can not look for material improvement in the situation until the extensive program for double tracking the line of the Florida East Coast between Jacksonville and Miami and the enlargement of terminal facilities now well under way are completed.

The aggregate number of cars loaded with revenue freight during the year ended October 31, 1925, is estimated as 50,934,000, which surpasses all previous high records. In that period the carriers reported on line, available for service, a daily average of 245,000 railroad-owned serviceable freight cars which were idle because the supply exceeded the demand. The minimum number of such idle cars was 111,619 on October 31, 1925, and the maximum number 344,959 on March 31, 1925. For the 12 months ended October 31, 1924, 1923, and 1922, the total loading approximated 48,374,000, 49,794,614, and 41,868,771 cars, respectively.

In the week ended August 29, 1925, there were loaded 1,124,436 cars of revenue freight. This established a new high record for one week, and exceeded by 11,383 the preceding peak of 1,113,053 cars loaded during the week ended October 25, 1924.

The increase in freight traffic has been due principally to greater movement of miscellaneous carload freight and less-than-carload shipments. Miscellaneous carload freight, which includes iron and steel, cotton, road and other building materials, petroleum, produce, packing-house products, perishable commodities, vehicles and other manufactured articles, and many miscellaneous items, approximated 18,629,000 carloads in the year ended October 31, 1925, compared with 17,212,000, 17,206,938, 14,361,511, and 13,140,666 cars in the 12 months ended October 31, 1924, 1923, 1922, and 1921, respectively. Less-than-carload shipments of merchandise and other items aggregated 13,113,000, 12,487,000, 12,054,289, and 11,841,641 cars in same periods of 1925, 1924, 1923, and 1922, respectively.

Employment of Blind War Veterans in Germany

Through the courtesy of the Siemens-Schuckert Works, Berlin, and one of its directors, Herr Paul H. Perls, we are able to show the progress Germany is making in employing her blind war veterans. Heretofore the theory has been maintained that with the technical development of the machine industry, crowding out, as it does, handwork to a large degree, blind handworkers had no place. Before the war employment of the blind was principally confined to basket making, weaving of chair bottoms brush making and similar occupations. This work is even today still accomplished in homes and institutions for the blind.

Since the war various German industries have voluntarily taken a deeper interest in the country's blind believing that every human being, including the blind, has a right to live and to work, and in an increasing degree the blind in Germany are being placed at the work bench of the "seeing," from which they have heretofore been excluded.

Handwork, which is still an important phase in all industrial activity, is not sufficiently remunerative for either the blind or the seeing. For this reason efforts were begun even during the war in 1915, with the assistance of capable technical leaders, to employ the blind in serving machines. The accompanying illustrations show how the intelligent blind are maintaining their positions in the large industiral concern of Siemens-Schuckert, Berlin.

It has been satisfactorily demonstrated that the blind are fully capable of executing especially difficult work; for instance, the boring of a series of holes in metal with the aid of a pattern. The efficiency of the blind is further shown by their ability to serve simultaneously two and three semi-automatic drilling machines.

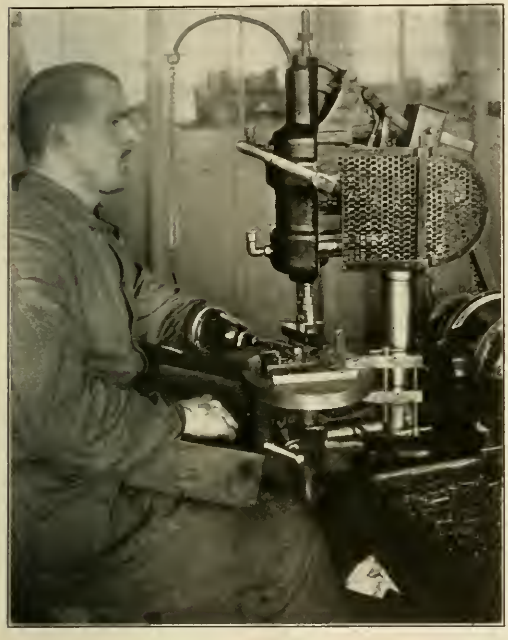
Experience has shown that machine-work is best adapted as it restores self-confidence and encourages the blind to further efforts.

Blind One-Hand Operator, Attending Horizontal Thread Cutting Lathe

The chief difficulty in introducing machine-work lay in providing suitable protection against injury, especially to the hands; unless the man is quite certain that he is not in danger, he cannot be expected to work with full confidence. For instance, punching machines have been so arranged that the punch cannot operate unless both hands work the lever; riveting machines automatically push the hands away when they come too near.

Lectures have been held and photographs distributed showing how successfully the blind are being employed in the Siemens Works, with the result that numerous other concerns have decided to follow their example; even foreign representatives of industry have shown their interest by visiting the works.

A deputation consisting of an eye specialist, a director of a home for the blind, a manufacturer, a factory inspector and a blind man visited several works in order to consider the possibilities of occupation for the blind; it was shown that there are over 100 possibilities of occupation in workshops. Even in commercial life their usefulness has been proved by successful work in correspondence, taking down notes on their machines and afterwards transferring them to the typewriter.



Vertical Thread Cutting Machine, Operated by Blind Man With Amputated Lower Arm. Artificial Arm is Supported From Above

The German law providing that at least 2 per cent of the workers employed in any factory must be cripples has been a great help; men crippled by accident and those born blind are included in this law, which must be strictly adhered to. The City of Berlin has a special labor exchange through the efforts of which 114 blind men found occupation in the first half year of its existence.

Correct handling of the blind is of great importance, as they are very often extremely depressed over the calamity which has befallen them. Their work-benches have been placed alongside with men able to see, which has done a lot towards regaining their courage. They should be dealt with individually, however, and foremen and those in authority pay special attention to this feature.

The street cars provide free passage to and from the place of work on presentation of a certificate. The so-called Germany shepherd dog is very useful in guiding the blind and often proves to be his best friend; during working hours the dog's place is under the work-bench.

As far as possible the blind, who are mostly married, receive lodgings in Siemens Town so that it is not necessary for them to take the train or street car. Additional buildings are being erected and it will be so arranged that one blind man will be domiciled in each set of flats, so that here also he will live among people who are able to see. The blind in the hospitals who complained of continual headaches, report that they feel much better now that they have an occupation, and are able to drown their troubles in work. Those who were formerly used to heavy work stand at their machines so that they have an opportunity of using their strength, while the weaker ones should be provided with chairs.

Vertical Thread Cutting Machine, Operated by Blind Worker With One Arm and Paralyzed Right Hand. Knee of Right Leg is Used to Prepare Part to be Threaded

The Siemens convalescence home on the Baltic coast provides a four weeks' holiday yearly, the journey going and coming, as well as assistance for the family being free of charge.

The following blind are employed in the Siemens Works:

Factory for small parts, Siemens town, near Berlin..	46
Factory for small parts, Sonnenberg, Thuringen....	2
Factory for electric motors, Siemens Town........	2
Factory for switchers, Charlottenburg.............	4
Factory for cables, Gartenfeld, North Berlin........	1
Factory for meters, Nurenberg	25
Factory for porcelain, Neuhaus	1
Wernerwerk, Siemens Town	14
Telephone works, Charlottenberg.................	7
Austrian S. S. W. Vienna......................	2
Siemens & Halske, Vienna......................	6
	110

Statistics and Their Value in All Phases of Railway Economics

By W. E. Symons

Statistics are employed as a means of placing before the human eye for transmission to the mind, through the science of numbers and the art of computation by figures, a true picture or actual display of facts, conditions, etc. It therefore follows, that as everything is relative, and justice itself is the result of study and comparison, that statistical tabulations are the foundation of knowledge, and in this day of human progress, those who fail to appreciate the great value of statistical comparisons are denying themselves the wonderful educational advantages enjoyed by the greatest engineers and business experts in the world.

Aside from the progress made by accounting and statistical officers of our railways, the Interstate Commerce Commission has since 1888 developed a wonderful system of accounting and while some of the records required of the carriers, from which certain reports are made are thought by some to be unnecessary, yet the majority of them are essential to a proper knowledge, or *correct picture* of the situation.

Among the numerous publications, reports and statements issued by the commission, one might be mentioned to illustrate and emphasize both the extent and value of their contents generally.

Statment No. 25200 extends to 115 pages. It is a Corporative Statement of Operating Averages, Class 1 Steam Railways, covering the years 1921 to 1924 inclusive. Briefly, let us consider some of the things this statement contains.

Complete detailed operating statistics of 210 *railways*

Statistical items numbered for each line........	46
Additional items by symbols a, b, c, d, etc........	88
Total items for each carrier entered............	134
Total items for one year's comparison...........	28,140
Total items for four years' comparison..........	112,560

So here we have aside from, and in addition to, three pages in elite type of explanatory matter and one full index page, a statistical tabulation with the same item for four different years for each carrier, and three carriers' reports placed side by side giving at a glance twelve figures, from which to absorb information, make comparisons and reach conclusions.

On each page appears at a casual glance of the eye 1,603 items, while on the two opposite pages combined there appears for reference 3,206 items of operating statistics, each line with 12 items on each page covering four years results on three different roads.

ITEMS		1916	1917	1918	1919	1920	1921	1922	1923	1924
Investment in Road & Equip (Book Value)	(1)	$16,884,440,038	$17,762,152,127	$18,213,629,613	$18,529,749,653	$19,061,239,186	$19,578,545,638	$19,871,241,404	$20,657,166,329	$21,473,257,747
Material & Supplies	(2)	323,556,387	502,986,042	629,674,660	629,674,660	755,563,278	665,147,099	546,284,855	682,725,812	560,048,899
Total	(3)	$17,207,996,425	$18,265,138,169	$18,842,904,273	$19,159,024,313	$19,816,802,464	$20,243,692,737	$20,417,526,257	$21,339,892,141	$22,033,306,646
Cash	(4)	$428,725,805	$341,696,264	$355,569,015	$355,559,015	$369,421,765	$418,265,549	$483,717,274	$407,339,592	$516,386,738
Grand Total	(5)	$17,636,722,230	$18,606,834,433	$19,198,463,288	$19,514,583,328	$20,186,224,229	$20,661,958,286	$20,901,243,631	$21,747,231,733	$22,549,693,384
Average Mileage		250,991	252,199	233,203	233,608	234,668	234,419	234,826	235,185	235,496
Average Amount Per Mile	Item 1	$73,095	$76,495	$78,101	$79,319	$81,226	$83,519	$84,621	$87,706	$91,140
	" 2	$1,400	$2,166	$2,700	$2,695	$3,219	$2,837	$2,326	$2,902	$2,376
	" 3	$74,496	$76,661	$81,229	$82,013	$84,445	$86,356	$86,947	$90,736	$93,561
	" 4	$1,423	$1,471	$1,524	$1,621	$1,574	$1,771	$2,056	$1,732	$2,192
	" 5	$76,350	$80,133	$82,325	$83,535	$86,024	$88,141	$89,007	$92,468	$95,763
Units of Rolling Stock	Locos	61,332	61,890	63,889	64,983	64,746	64,949	64,512	65,327	65,358
	Pass. Cars	52,179	52,977	53,941	53,765	53,501	54,331	54,354	54,718	55,042
	Frt. Cars	2,280,955	2,330,123	2,354,244	2,389,860	2,350,707	2,344,780	2,322,286	2,354,591	2,379,047
	Wk. Equip.	97,197	99,876	101,475	103,606	104,805	104.390	105,576	108,837	108,809
Total Rolling Stock		2,491,663	2,544,866	2,573,549	2,612,214	2,563,759	2,568,450	2,546,728	2,583,473	2,608,256
Aver. Material & Supplies Per Unit Rolling Stock		$125.44	$197.65	$244.67	$241.41	$294.74	$258.96	$214.50	$264.26	$138.04
Total Operat. Expense		$2,357,398,412	$2,829,325,124	$3,982,068,197	$4,399,715,515	$5,827,591,146	$4,562,668,302	$4.414,522,334	$4,895,166,819	$4,507,846,037
Per Cent (Material & Supplies (To Operat. Expense		13.72%	17.77%	15.05%	14.31%	12.95%	14.57%	12.35%	13.99%	12.41%
Total Net Ton Miles		396,365,917,082	430,319,014,635	440,001,713,665	395,679,051,729	447,278,209,869	340,862,150,770	371,945,560,691	456,237,879,523	426,833,488,811
Ton Miles Frt. Moved, to Each Dollar in Mat. & Sup.		1,225	855	695	628	592	512	679	669	762
Operating Ratio		65.54%	70.48%	81.58%	85.52%	94.32%	82.71%	79.41%	77.83%	76.13%

Statistics of Class 1 Railways With Annual Operating Revenues Above $1,000,000 and Which Represent About 90 Per Cent of the Mileage and 96 Per Cent of the Railway Revenues of the Country

The wide range of fluctuation in some of the most important items in railway operation will serve to emphasize the great' potential value of comparative statistics in formulating even an adjustable "yard stick" for measuring results.

TABLE 1

Items	From	To	Ratio Between Unit Averages
Repairs per locomotive in service........	$1,928	$17,705	8.71
Repairs per freight train car in service....	18	$439	23.83
Maintenance per equated track mile........	$475	8,919	18.75
Train load-tons per train R. & N. R. R...	141	1,952	13.84
Earnings per freight train mile..........	$3.35	$28.16	8.40
Earnings per passenger train mile..........	40c	4.36	10.90
Pounds coal per 1,000 gross ton miles.....	69	276	4.00
Pounds coal per passenger car mile......	13.2	30.6	2.31
Material and supplies per mile...........	$.321	$26.180	81.55
Gross earnings per mile.........	$1.816	193.187	106.38
Freight train, speed miles per hour........	3.8	19.2	6.03
Operating ratio per cent.................	162.3%	68.6%	2.36

It is a study and comparison of these items that gives the student of railway economics a true picture of the situation, from which he may focus his angle of vision on the correct or vital spot with a minimum of time and effort, and with assurance of being properly qualified to intelligently proceed to a solution of such problems as may require attention.

Nine Years Record of Class 1 Railways

As a further illustration of the great value of comparative statistics in all phases of railway ownership and operation attention is invited to the next following table with 22 lines or items over a period of nine years for all class 1 railways which embraces about 90% of all mileage and 96% of all revenues.

This table is so full of valuable items for comparison that it would be difficult to give preference to any particular one, suffice to say that any one seeking knowledge on any of the items here classified, cannot give this table much thought without deriving great benefit therefrom.

Reports Made by Class 1 Railways

One of our leading railway presidents recently gave out some interesting data on the heavy tax imposed on class 1 railways in the matter of making reports for municipal, state, government, and other regulatory bodies, etc.

The actual number of reports required is in round numbers 2,000,000, and as there are numerous duplications, corrections and additions, it seems safe to place the total at 3,000,000 per year. •

On a basis of 3,000,000 reports the average per day would be 10,000 or 1,250 each hour.

In this calculation it is assumed the clerical or office forces, after deducting all holiday and short Saturdays, work 300 days of 8 hours, or 2,400 hours per annum.

If these 3,000,000 reports have an average of 134 items each, then the total number of items to be prepared from numerous docuntents, way bills, supplementary reports, time slips, invoices, and other sources, would be about 402,000,000.

In many of these reports the preliminary work, together with rechecking all elements entering into the complete or final figures, is far in excess of the time, effort and expense in the report itself, so that from a standpoint of a fair measure of the extent to which this constitutes a burden on the carriers' facilities and treasury, it may safely be said that the case is *understated*, rather than fairly appraised.

In the face of the foregoing and the well known fact that the leading railway officers, financiers, engineers and experts of the world, actually look to such displays as an inspiration and guide, there are those who scoff at *figgers*, and say they are of little or no value.

Wrench Head Bolts and Nuts and Wrench Openings

A sectional committee under the sponsorship of the Society of Automotive Engineers, and the American Society of Mechanical Engineers was organized in March, 1922, to prepare specifications for wrench head bolts and nuts and wrench openings for the American Engineering Standards Committee. The subcommittee No. 2 has completed the tentative specifications for submission for approval. This sub-committee consists of forty-nine members representing twenty national organizations.

These proposed standards are intended for general use by all industries and the consequent replacement of the various existing standards now in use in these industries. Publicity has been given to the work of the Sub-Committee on Wrench Head Bolts and Nuts and comments have been received from users and manufacturers. Tables have been circulated and studied both from the point of view of the existing stocks and tools on hand and from the point of view of the theoretically ideal product. As is generally known, the Sub-Committee found a large number of standards in use in various sections of the country and wide variations in practice by both makers and users. The work of foreign standardization committees has been considered and analyzed but it has been thought by the Committee that the reduced costs of the product as set forth in these tables should outweigh any consideration of increasing bolt head and nut sizes simply to agree to foreign practice.

The Sub-Committee has analyzed existing practice in this country and has attempted to work out tables of dimensions which will be acceptable to various industries and which will cause least disturbance of present practice. Wherever possible the U. S. standard sizes of bolt heads and nuts have been reduced to some existing shop standard after giving consideration to theoretical analysis of stresses in bolts and nuts and making tests of samples. Deviations from theoretical sizes have been made in order to keep the number of wrench openings small and to conform to certain manufacturing processes. In fixing tolerances it has been difficult to obtain information from manufacturers. Some manufacturers take tolerance from basic size in a plus direction, some in a minus direction, others in both drections. The greatest possible tolerances have been allowed with the realization that they will seldom be found in the product and that the manufacturer will set up his working gages in such a way as to rob the workmen of part of the tolerance, thus insuring that all the product which is accepted by working gages will easily pass the inspection gage.

It has seemed desirable to reduce the number of wrench openings required, through simplification of outside dimensions of bolt heads and nuts and elimination of sizes little used. This action tends to reduce the number of sizes of stock for manufacturing which are carried by manufacturers. This has caused deviations from results calculated by formulas for sizes of bolt heads and nuts due to eliminating the thirty-seconds from all sizes. The S. A. E. standards had already been published, showing a similar practice.

The sizes of bolt heads and nuts are intended to supersede all existing standards which have grown up for commercial standard bolt heads and nuts. Special considerations may indicate the need of other sizes and in the practice of certain users there will be specifications for U. S. standard sizes. It is not expected that these will be carried in stock as a commercial standard but must be specially ordered.

It will be noted that the maximum sizes of both finished and rough products are the same so that wrenches are applicable interchangeably to either class of bolt head or nut.

In all cases the *nominal* or *basic* widths across flats of bolt heads and nuts have been taken as *maximum* sizes and the tolerances on bolt heads and nuts are *minus* only.

The *minimum* wrench openings have been made to provide a positive *clearance* between maximum nut and minimum wrench and the tolerances on *wrench openings* are *plus* only. This insures a fit of the wrench to the bolt head and nut. The tolerance allowed the wrench manufacturer has been made as great as is possible without causing the deformation of the corners of bolt heads or nuts.

The report contains ten tables, each giving the detailed dimensions that are proposed, and criticisms are requested. As the matter is of great interest to all railroad men it is suggested that it would be well for them to obtain copies of these detail tables. This may be done by applying to C. B. Le Page, assistant secretary of the American Society of Mechanical Engineers, 29 West 39th St., New York.

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Locomotive Development

It is very interesting to watch the development of the locomotive in its gradual approach to a theoretically perfect efficiency, which it can, of course, never reach. Then, too, with each advance that is made the next step becomes increasingly difficult.

It is not so very many years ago that the locomotive with its cold feed water pumps and slide valves, with slide valve throttles was well on in the lead of steam engines of low efficiency. We knew this from even the sparing use of the indicator and the still rarer performance tests that were made. In those days to equal the performance of a condensing engine of the same period with a locomotive was considered such an impossibility as to be beyond the wildest of dreams. Yet the locomotive has been brought to such a condition of efficiency as to surpass the performances of even the compound condensing stationary engines of a few decades ago.

There is no one thing that can be held responsible for the difference between then and now. The first advances were made by an increase in boiler pressure, rising slowly from 120 lbs. per sq. in. At a pressure of 125 lbs. there was a long pause then a sudden jump to 140 lbs., and thereafter a slow but fairly steady increase extending over a period of twenty years or so to 200 lbs. and each advance accompanied by a corresponding increase of efficiency.

Then there were the auxiliaries. Among the first of which was the injector, about as unreliable method of putting water into a boiler as can well be imagined, and it was several years before the crosshead pump was discarded and we dared trust to the injector alone.

The brick arch came and went and finally came to stay. Our front ends have been subjected to every conceivable modification before reaching their present stage of development; while it took twenty odd years of constant experimentation and refinement to make the mechanical stoker the successful rival of expert hand firing as a method of putting coal into the firebox.

The old Stephenson valve gear was grossly abused in its designing and often failed to make a proper steam distribution because of the ignorance or carelessness of its designer. The Walschaerts was adopted here after a half century's life abroad, more in order to get an outside gear leaving the space between the frames clear for bracing and to cut down the weight, than for any thought of securing a more economical steam distribution. Piston valves came in order to secure better balancing and avoid the weight of the cumbersome slide valves. So that as far as our actual knowledge was concerned we had made but little advance in sixty years. We had become more careful in our designing to be sure, but that is all.

We had a struggle with our superheater, but it was short, sharp and decisive, and that device soon became as much a part of a locomotive as its wheels, and great have been the economies resulting therefrom.

About six years ago the Pennsylvania built a locomotive for pushing service in which the maximum cut-off at half stroke was incorporated. At the time the engine was designed, it was not expected that it would be used for other than a pushing service where it was desired to use the maximum tractive effort at all times. But the engine was so successful and economical in this work that a large number were soon built and put into regular road service. For some reason the idea was not widely adopted and comparatively few have been built for other railroads.

And now we have this latest development of the locomotive, whose performances are recorded in another column of this issue. In this engine there is incorporated about every device that makes for economy of operation, and the results more than warrant the painstaking care of the designers. Not only have they availed themselves of everything of value that has gone before, but they have incorporated others that are both original and bold; not the least of which is the four-wheeled trailer truck. This is not only a truck, in that it serves to carry the rear end of the locomotive, but it is a separate vehicle for the transmission of the pull of the engine frame to the train, just as the tender has always served a similar purpose.

It is known that the stresses imposed upon the track by the trailing trucks of Mikado, Pacific and Mountain type locomotives are high, even higher than that imposed by some of the driving wheels, so that it is a safe guess to assume that the stresses imposed by this guided truck will be materially less than those imposed by the ordinary trailing truck.

What the next advance will be it is difficult to say. We have so often thought that we had touched the ultimate and been mistaken, that we can only accept this latest development as an accomplished fact and look forward with wonderment as to what the morrow will bring forth.

As to Car Designing

One who has had extensive experience in the designing and operation of steam railway freight cars has set forth a few suggestions, which, as he expresses it, are not found in books. He suggests that, in starting to lay out the design of a car, the draft gear should be laid down first. In doing this sufficient room should be allowed for draft gear back stop, separate from the center brace, with ample riveting, paying particular attention to having the rivets easily accessible for good driving.

Having located the center brace, free from contact with the draft gear back stop, the end of the body can be located and decision made as to whether an inside or outside end sill is to be used. Then, having the end of the body located in relation to the center of the truck, and knowing the length of the body needed, the distance from center to center of the trucks is determined.

On the other hand, if we go about it the other way and first locate the distance from center to center of the trucks and the length of the body, a certain space will be left for the draft gear. Then on attempting to lay it out, it will usually be found that there is not enough space to secure sufficient draft gear riveting, with the result that it is sometimes necessary to combine the back stop and the center brace in one casting, which is very objectionable, as the casting must then take half the load of the car, besides sustaining the shock of the truck blows in switching, as well as those of the draft gear.

This riveting of the back draft gear stops is a most important matter and should be so designed that the rivets should not be stressed, in shear, more than 50,000 lb. per sq. in. of rivet section when the end shock amounts to as much as 800,000 lb.

In the matter of determining the distance from center to center of the trucks of hopper coal cars, the bottom slope sheet should be, first, so located as to give the wheels a clearance on the maximum curvature. This done calculate the volume of the wedge-shaped space above the slope sheet. Then make the length of the car enough to carry the load and the distance from center to center of the trucks will be automatically determined.

In this case the draft gear layout can then be made, or, if previously made, applied, and this will then determine the length of the car.

In this connection it is impossible to overemphasize the desirability or even the necessity for using a better design of center brace for freight cars than that which is usually found; especially in heavy capacity cars such as coal and ore cars. The ordinary design can be greatly improved by lengthening the casting, planing it and providing ample space for the riveting. The planing may at first appear to involve a refinement that is unnecessary, but when the probable stresses to which the casting is to be subjected are taken into consideration, desirability of having as perfect a fit and bearing as it is possible to secure, will be recognized. Few men realize the avoidable expense now incurred in the maintenance of new cars, because of a poor center brace construction. So that when a poor construction means expense and a good one a saving of that expense, it is the part of folly to go blindly along in the old rut when a good construction is so readily available.

In considering the fifty-ton box car, a strong preference is expressed in favor of an all steel, double sheathed car, floored and lined with wood. That is, steel outside sheathing and wood inside sheathing, such as the type X-29 built for the Pennsylvania system.

The truck side frames of some of these cars have the journal boxes cast integral with the frame while others have the Andrews side frame, with separable oil boxes. The latter are to be preferred, principally because it costs much less to replace worn wheels, and because the truck can be more easily repaired in case it is damaged by accident.

As very few 50-ton box cars are loaded to full capacity, it does not seem that the time has yet come, when even a large percentage of the box car equipment of the country should be made up of cars of 50 tons capacity, as a 40-ton box car is a better average moneymaker for the railroads than one of 10 tons greater capacity.

The 50-ton box car built for the Philadelphia & Reading in 1919 is also one of the best of its kind. It has a steel underframe, a steel superstructure and steel roof. It is single sheathed with tongue and groove siding; that is, it is what is known as a single sheathed box car.

The objection to the single sheathed car is that it has a tendency to leak.

As for steel ends, experience seems to show, that though they are pretty generally used they are not a necessity, and that a much lighter end, weighing probably as much as 2,000 lb. per car less can be made up of Z or U bar construction, which will not only answer every purpose but whose first cost as well as that of maintenance is much less.

New Valve Gears

It has often been said that everything is worth trying once, and perhaps it is so. At any rate there have been a wide variety of things tried and even extensively used that have not survived the hard knocks of practical service. This has been especially true of the various types of reversing valve gears for locomotives. Many have been called but few chosen.

The Stephenson gear that held its own in this country for so many years, was really nothing more than a growth of development of the original drop hook motion. Turn one of the hooks upside down, join their wide, flaring points, and then draw these points in towards each other until the sides are always in contract with the block, and you have the link in its crude form. Refine this by a proper location of the eccentric rods and saddle pin and give the faces of the hooks a suitable curvature and there is a valve motion whose sensitiveness can only be appreciated by those who have studied Auchincloss and worked over a proper adjustment of the gear itself.

So with the Walschaerts. He took the old single eccentric set nearly at right angles to the crank and attached it to a lever pivoted at the center with a block sliding along its surface, so that as it passed the pivotal point, the movement of the valve is reversed. It then remained to refine it; curve the lever, attach the eccentric rod in the proper place and so adjust the several parts as to make a workable gear. In like manner it took something more than a hundred years to so develop the Hackworth gear that it would give satisfactory results on a locomotive.

But in all of these widely adopted gears and in their development, the whole tendency has been towards simplicity of construction and operation. In the Stephenson gear there were but four separated moving parts between the eccentric and the valve stem. In the Walschaerts gear there are but six, including the union bar, and all are rugged pieces, readily accessible and not likely to get out of order.

No one claims that absolute perfection has been reached by any of these gears. Like the poor, the angularity of the rods and connections is always with us and this angularity is responsible for many of the irregularities that everyone recognizes. It is these irregularities of action that the valve motion perfectionists are trying to remedy.

Take the case of the Caprotti valve gear illustrated in the February, 1925, issue of RAILWAY & LOCOMOTIVE ENGINEERING. It is a device that is interesting because of the extensive application that it has received on the Italian State Railways as well as the wide publicity that it has received in the foreign press. It does away with the angularity of the connections, the slip of blocks and by the use of cams ought to be able to obtain such an equalization of valve events as to do away with the irregularities in the gears which we are using. But like many other gears that have gone before it, it is made up of a large number of moving parts, many of which are so inaccessible that inspection, under running conditions would be next to impossible, and it is to be feared that maintenance costs would be prohibitive.

It is very desirable that a locomotive should work evenly and smoothly, but more desirable than that it should work smoothly is that it should always be ready to work. It profits little to save a dollar in fuel consumption if it costs two dollars to make the saving.

It is, therefore with much interest that railway men will watch, not the action of the Caprotti valve gear as it works on short runs with light loads, such as those thus far reported, and in a new condition, but how it will stand up to serve punishment and the stresses of long runs with heavy trains moving at high speeds, kept up day after day.

To put it mildly it is another case where one is justified in having his doubts.

Consistency in Railway Economics

When Measured by Operating, Engineering or Financial Yardsticks.

Great credit is due statesmen, scholars, engineers, inventors and financiers for the wonderful progress made in all branches of the arts, sciences, industry and transportation, which have materially added to the wealth, prosperity and happiness of civilized people.

Both in retrospect, and by present day survey, however, we can, without being unmindful of past achievement, observe many great improvements or inventions that were unnecessarily delayed in development, while there are certain features of otherwise highly developed units that have received little or no attention whatever, when compared to the completed unit of which they are an integral part.

In order to more forcibly illustrate this latter point, the inconsistency of millions of our best people in their private life and personal habits will serve as a good example. These splendid people who are models of integrity, culture, refinement, and all that embodies the highest type of our citizenship, but who not only condemn the use of alcoholic liquors, but abhor all who may use it in moderation, are as a matter of fact very often notoriously intemperate in matters of food, dress and personal habits. In other words they are not "consistently temperate."

In applying this principle to railway economics, there seems to be more than one feature or part of certain units which it would appear have been more or less neglected, when measured by other features or the completed units that have been so wonderfully improved, particularly in recent years.

The American Locomotive

Almost any student of the development of the steam locomotive here and abroad, will not hesitate to admit that American railways have the equal if not the most efficient engines. While many hold that the limit of size and efficiency has been reached, there are those who feel that in the matter of efficiency, or consistency in refinement of all integral parts, there is not only room, but a crying need for improvements that have been neglected if not ignored.

Some years ago there was much said about the damaging effects on track, bridges, etc., and to the engine itself, by the unbalanced portion of the revolving and reciprocating parts of our standard engine, with two cranks at 90 degree angles and 270 degree dead zone. The dynamic augment, or as it is more commonly called the "hammer blow," delivered to the rail each revolution of the engine, was both injurious and expensive to the track and the engine, and means was sought for its reduction or elimination. The four-cylinder balanced compound engine, with four cranks at 90 degree angles and almost a constant turning torque was hailed as the medium through which these ills would be remedied.

No one who had given the subject careful thought questioned the superior merits of the four cylinder four crank engine, in so far as track maintenance was concerned, but there was decided objection to a two crank axle, and as superheating was at that time being successfully employed as a means of increasing efficiency and saving fuel, we rushed to the superheater, and delayed an effort to solve the hammer blow or dynamic augment problem.

The rolling and pitching of the locomotive when under way, the extent of which is of course largely, if not wholly, governed by design, size, track conditions and speed, is another feature that in its effect on permanent way and the locomotive itself is rather closely related to dynamic augment.

That particular part of the physical anatomy of steam locomotive most directly involved in this matter has remained practically unchanged, in principle, since the construction of the first locomotive. In view of the great expense involved in the maintenance of way and motive power it would seem not inappropriate to suggest that this particular feature be taken in hand with a view to making such improvements as have already been made in most other integral parts of the finished unit.

Cost of Maintenance

The cost of maintenance of way and structures and equipment of class 1 railways is as follows:

Maintenance of way and structures	$ 803,598,961.00
Maintenance of equipment	1,462,222,167.00
Total	$2,265,821,128.00

This is subdivided into 137 items and amounts to 46.28% of the entire operating expense.

As the entire expense of maintenance of way and structures is not affected by, or chargeable to the feature of locomotive design in mind it is proper to make such subdivision as will eliminate items of expense that should not be included.

Maintenance of way and structures which are affected and should be included:

Roadway maintenance	$ 75,972,234.
Bridges, trestles and culverts	41,762,083.
Ties	102,196,062.
Rails	31,622,243.
Other track material	32,528,643.
Track laying and surfacing: $185,169,404, 10% of this item	18,516,940.
Total	$302,598,205.
Locomotive repairs	559,280,737.
	$861,878,942.

In order to be on the side of conservatism, let us assume that a better behaved, or thoroughly stabilized engine, particularly at high speeds on track with the usual imperfections as to surface and alignment, would result in a saving on these items of five per cent which would amount to $43,093,947.00. There are other advantages, not computable in dollars and cents, but so far in excess of the estimated money saving on maintenance charges, that some students of this feature of locomotive design, wonder why it has not received long ago the attention it deserved.

Fuel Economy As Affected by Front End Arrangements

Another most important feature of locomotive design that has been badly neglected, is the front end arrangements of locomotives, particularly the exhaust nozzle and other parts that have to do with proper drafting of locomotives, and back pressure on pistons.

For the past 25 to 30 years almost a constant protest has been made against the great waste in locomotive efficiency and fuel due to negative action as to these particular features. While the locomotive as a whole has been wonderfully improved in most all other respects, yet failure to consistently bring these features up to the general high standard of other parts, has in a great measure negatived the value of the improved parts, and of course efficiency of the completed unit.

Aside from the efforts to arouse some degree of enthusiasm on this question of excessive back pressure on pistons, there has appeared in the columns of RAILWAY AND LOCOMOTIVE ENGINEERING during the past two or three years a series of articles in which the scientific, practical, and economical features of the question have been clearly explained. While these are defects that can easily be overcome, it seems almost impossible to get those in authority to see the point, and move as effectively as they have already done with respect to other features of design, some of which are of less importance.

It has been pointed out that the saving in fuel alone on about one-half of the locomotives in this country, resulting from eliminating unnecessary excess back pressure on pistons, would amount to more than $25,000,000.00 annually, and to this should be added the money value of the increased efficiency of the locomotive as an integral part of a complete transportation unit.

Now that such wonderfully big things have been accomplished in the design of our ultra-modern locomotives, why not be consistent and advance or raise this average high standard of efficiency, by improving some of the features which have been neglected.

Santa Fe Type Locomotives for the Atlantic Coast Line R. R.

Develop 75,700 Pounds Tractive Force and Are the Heaviest Locomotives Used on This Road

The Atlantic Coast Line has recently received, from The Baldwin Locomotive Works, 15 locomotives of the Santa Fe (2-10-2) type, which exceed in weight and hauling capacity any locomotives previously built for this road. The new engines, designated Class Q-1, are operating in the Montgomery, Alabama, district, on grades of 1.65 per cent and curves of 12 degrees. Their dimensions, as compared with those of the Mikado (2-8-2) type locomotives formerly used in this district, are given in the following table:

Type	Cylinders	Drivers Diameter	Steam Pressure, lbs.	Grate Area Sq. Ft.	Water Heating Surface Sq. Ft.	Superheating Surface Sq. Ft.	Weight on Drivers pounds	Weight total engine pounds	Tractive Force pounds
2- 8-2	27"x30"	63"	200	73.5	3253	718	232,430	295,030	59,000
2-10-2	30"x32"	63"	195	88.2	4975	1230	303,060	391,980	75,700

This represents, for the new locomotives, an increase in tractive force of 28 per cent, with a materially greater increase in boiler heating surface.

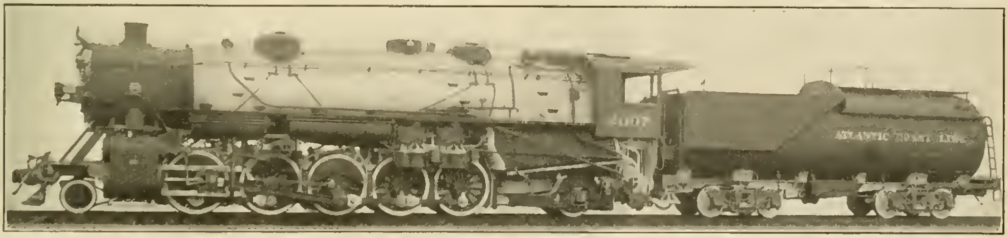
The general design of these locomotives is based on that of the standard heavy U. S. R. A. locomotives, with details modified to suit the special conditions on the Coast Line.

The boiler is designed for a pressure of 210 pounds, but in service the safety valves are set at 195 pounds. The diameter of the largest ring is 100 inches. In accordance with Atlantic Coast Line standards, all seams in the firebox and combustion chamber are welded, and the tubes are electrically welded into the back tube sheet. The arch is supported on five 3-inch tubes. Duplex stokers are installed, these being the first locomotives used on this road to be stoker fired.

The injectors on the right-hand side are of the feed water heating type—exhaust steam from the cylinders being used principally in their operation. The left injectors are of the non-lifting type, 7,500 gallons capacity. Lubrication of the valves, cylinders, air pump and stoker is accomplished by a force feed lubricator, replacing the hydrostatic feed entirely.

Flanged tires are used on all the driving wheels, and lateral motion boxes on the first driving axle. The rear truck is of the Delta type, and the Commonwealth cast steel frame cradle is applied.

The steam distribution is controlled by 14-inch piston valves, which are operated by Walschaerts gear and set with a maximum travel of 7" and a lead of 3/16". The steam lap is 1⅛" and the exhaust lap zero. The crossheads are of vanadium steel, with gun iron shoes. The back ends of the main rods, and the middle connections of the side rods have floating bushings. The fixed bushings in the side rods are of steel, working against bronze wearing plates in the crank pin hubs.



New 2-10-2 Type Locomotive of the Atlantic Coast Line Built by the Baldwin Locomotive Works

The tenders of these locomotives are the largest thus far built for the Coast Line, as they have capacity for 12,000 gallons of water and 16 tons of coal. These are also the first Vanderbilt type tenders to be used on this road. The frames are in one piece, of cast steel.

Further particulars of these interesting locomotives are given in the table of dimensions.

WEIGHTS, PROPORTIONS AND DIMENSIONS OF NEW MOUNTAIN TYPE LOCOMOTIVES FOR GRAND TRUNK WESTERN

Type	2-10-2
Service	Freight
Fuel	Soft Coal
Builder	Baldwin Locomotive Works
Cylinder, diam. and stroke	30 in. by 32 in.
Valve gear	Walschaert
Valves, piston, diam	14 in.
Wheel basis:	
Driving	22 ft. 10 in.
Rigid	22 ft. 10 in.
Total engine	42 ft. 9 in.
Total engine and tender	83 ft. 0½ in.
Weights in working order:	
On drivers	303,060 lbs.
On leading truck	27,120 lbs.
On trailing trunk	61,800 lbs.
Total engine	391,980 lbs.
Total engine and tender	613,000 lbs.
Wheels—diameter outside tires:	
Leading truck	31¾ in.
Driving	63 in.
Trailing truck	43 in.
Journals, diam. and length:	
Driving, main	12½ in. by 13 in.
Driving, others	10 in. by 13 in.
Leading truck	6½ in. by 12 in.
Trailing truck	9 in. by 14 in.
Boiler:	
Type	Conical
Diameter	88 in.
Working pressure	195 lbs.
Firebox length	132⅛ in.
Firebox width	94½ in.
Staying	Radial
Grate area	88.2 sq. ft.
Combustion chamber, length	132⅛ in.
Tubes, number and diam	256, 2¼ in.
Flues, number and diam	50, 5½ in.
Length tubes and flues	20 ft. 6 in.
Heating surfaces:	
Firebox	267 sq. ft.
Combustion chamber	120 sq. ft.
Tubes and flues	4,549 sq. ft.
Arch tubes	39 sq. ft.
Total	4,975 sq. ft.
Superheating	1,230 sq. ft.
Tender:	
Type	Vanderbilt
Wheels, number and diam	8, 36 in.
Journals, diam. and length	6½ in. by 12 in.
Capacity, coal	16 tons
Capacity, water	12,000 U. S. gal.
General data:	
Tractive power	49,600 lbs.

Industry Needs Reduced Taxation

Reduced taxes and a standardized and simplified method of assessing taxes, not only by the state but also the local governments, are the crying needs of agriculture, the railroads and all other classes of industry in this country, R. H. Aishton, President of the American Railway Association, told the joint conference between industry, agriculture and transportation which convened November 19, 1925, in New York under the auspices of the National Founders Association.

Referring specifically to the importance of a reduction in railway taxation, Mr. Aishton in a speech said in part:

"The present taxes on the railroads of this country are a burden and a growing burden. In view of the fact that the return realized by the railways of the country under the level of rates determined by the Interstate Commerce Commission has fallen materially below the standard of a fair return set up in the Transportation Act of 1920, this low level of return makes the increasing burden of taxes increasingly hard to bear. . . .

"There is an added burden in the fact that railways especially are subjected to a great variety of forms of taxation. . . .

"Not only does this multiplicity of the taxes levied on the railways create confusion, duplication and many inequalities as between corporations and regions, but adds another important element to the cost of railway operation in the expenditures required for the preparation of special reports, the filing of countless forms with governmental tax and other agencies, and the cost of the accounting for such reports.

Railway Taxes More Than Doubled in Eight Years

"Railway taxes more than doubled from 1916 to 1924 while in 1925 they are averaging almost exactly one million dollars a day or approximately $42,000 per hour. Taxes paid in 1925 are an increase of nearly six per cent over the amount paid in 1924 in which year they totaled $340,000,000. The amount paid in 1924 was an increase of $84,000,000 or thirty per cent over 1921.

"While railway taxes have been constantly increasing, there has been a reduction in freight rates during the four years since 1921 that has averaged more than thirteen per cent. During the year 1924 alone, and based upon the freight traffic handled in that year, the shippers of the United States paid a total freight bill smaller by more than $600,000,000 than they would have paid had the freight rates of 1921 remained in effect without reduction. This reduction has been made possible through large additions in capital investment, which have resulted in increased efficiency and economy in operation.

"The decline of thirteen per cent in the average freight rates, compared with the increase of thirty per cent in total taxes paid by the railways since 1921, furnishes a significant commentary on the increasingly cumulative burden of expense of government to the railways, as compared with the constantly decreasing expense to the public of transportation furnished by the railways.

"Railway taxes are a charge against public service corporations, that is, private property devoted to public service. In order to succeed in performing their duty of public service, the railways must be able to pay their operating costs out of revenues and be able to retain a sufficient margin in order to pay a reasonable return on investment, maintain sound credit and attract the necessary capital to make the required improvements and extensions which a growing demand for transportation service calls for. Adequate transportation service is of universal interest and adequate service cannot be secured nor maintained unless operating revenues exceed operating expenses, including taxes, and leave a fair margin of return on investment. As the matter now stands, the returns to the railways are too low and the burden of taxes too great.

Journal Lubricating Material Needs*

By L. R. Christy, Gen. Car Inspector, Missouri Pacific Railroad

There are no factors entering into the problem of car journal lubrication more important than the selection of proper materials, which means the procuring of the right grade of waste, oils of proper viscosity and refinement and suitable bearing metal. It is essential that the waste is free from rags, knotted fibres, particles of metal, grit and other foreign substances. The strands should be of proper lengths. The waste should be bought on specifications sufficiently rigid to permit of rejection of material which does not meet the requirements. The waste must have properties that give the necessary degree of resiliency to insure proper contact with the journal at all times, and must convey the oil to the journal with sufficient rapidity to maintain the lubricating film without breakage. There seems to be a fairly unanimous agreement that the two standard types of waste are preferable, one for use on locomotives and passenger cars, consisting chiefly of wool strands, another composed entirely of cotton strands for freight cars.

Numerous experiments have been made to obtain a bearing metal that will cause the least amount of friction, and yet be sufficiently strong to withstand pressure without crushing. Our standard lining metal is a tri-metal alloy, consisting of 85 per cent lead, 10 per cent antimony and 5 per cent tin. This closely follows the recognized standards of many of the principal railroads and is a satisfactory formula.

A lining metal of this kind with the great amount of lead will conform to the contour of the journal within a short time and reduce the unit pressure to a minimum. In the purchase of new journal bearings, and when old bearings are relined by outside companies, it is advantageous to have the test department of the railroads make periodical inspections at such plants to determine if proper compositions are used.

The subject of lubrication can not be discussed without considering the laws of friction. It is apparent that, were there no friction, there would be no necessity for interposing a lubricant between the journal and the bearing. The primary object of bearing lubrication is to provide a lubricating film between the rubbing surfaces, and thereby replace the metallic friction with fluid friction so far as possible, and then to minimize the fluid friction in the oil itself. Fluid friction is independent of the pressure on the surfaces in contact, but is directly proportional to the area of the rubbing surfaces.

If we will give but a moment's thought to this statement, we will realize that it is true, because any infinitesimal particle of oil will retard the movement of the entire body of oil, and as the viscosity of the oil increases the fluid friction increases. Compare the flow of oil from a receptacle, first using a light car oil and then a heavy valve oil. The light car oil will flow more readily because its fluid friction is lower than that of the valve oil. It must be remembered, however, that as the temperature of the bearing increases, the viscosity of the oil decreases. The body of the oil must be made to maintain the film without breakage at the normal running temperature of the journal. Experiments conducted to determine the relative temperature of journal, bearing and lubricant have indicated that the temperature of the lubricating film is higher than that of either the journal or the bearing. It, therefore, follows that the least viscous lubricant, not unduly influenced by great variations in temperature, is the most desirable car oil. The oils which best satisfy these requirements are mixtures of mineral oil and suitable fixed oils.

The Missouri Pacific installed during the current year waste renovating plants of modern design at two of its principal shops. All journal packing removed from locomotives, passenger and freight cars, in addition to waste used in shops is forwarded to these plants for renovation. The reclaimed journal packing is reimpregnated at these plants. New waste is saturated and prepared for immediate use.

The packing removed from journal boxes, and the discarded waste in shops is collected in specially constructed metal containers of approximately 300 lbs. capacity, marked to distinguish between packing removed from locomotives, passenger cars, freight cars and shops. As soon as sufficient quantities are accumulated at any point, shipment is made to the nearest renovating plant. These same containers are used in forwarding packing to the various locations and in this manner a sufficient number of containers are available always at both the plants and the outlying points on the railroad.

The waste is placed first in metal trays, where pieces of babbit, cinders, small stones and similar foreign substance are removed. This requires only a few minutes to each container of packing. The next operation consists of placing the waste in a heating tank, where it remains approximately 20 minutes, immersed in oil at a temperature of 130 to 140 degrees F. It is then forked up on a drain board and drained for a period of from three to five minutes. Then, the waste is removed to a motor driven centrifugal extractor, which equipped with a filtering arrangement is rotated for five minutes at the rate of approximately 1,200 revolutions a minute. At this stage of the process most of the oil has been removed, filtered and drained into an underground storage tank.

After this operation the waste is conveyed to a motor driven cleaning and drying machine, where the dirt is thoroughly removed and the waste is dried within 12 minutes. This machine is equipped with steam coils and air intake fan and operates under air blast at a temperature of 180 degrees F. The cylindrical container oscillates after making two and one-half revolutions in either direction. When the waste is removed from this machine, it has been thoroughly renovated and is ready for the saturation in the waste impregnator. This device by the combined use of a vacuum pump and compression head, actually accomplishes the complete saturation of the waste in less than five minutes.

In preparing packing from the renovated waste only reclaimed, filtered oil is used, which is pumped from the underground storage tank to the impregnator. Past experience has shown that one gallon of surplus oil accrues to every one hundred pounds of waste renovated. In other words, slightly more oil is recovered from this amount of renovated waste than is consumed when it is again saturated. It has been demonstrated that oil does not wear out in service, but simply becomes contaminated with foreign matter and after proper reclamation is as good as new oil. New oil is used with new waste in preparing new packing. In no case is new packing mixed with renovated packing.

An electrically operated machine for making packing rolls is also contained in this system. The capacity of

*From a paper read at the annual meeting of the Chief Interchange Car Inspectors' and Car Foremen's Association of America, at Hotel Sherman, Chicago, September 22 to 24.

each plant is two and one-half million pounds of renovated packing a year, which, reduced to an average daily production amounts to 9,000 lbs. The services of five men are required in connection with the operation of each plant.

This system has many advantages over the ordinary methods of reclaiming and saturating packing. The entire operation of renovating and saturating packing requires less than one hour, as compared within 48 hours, which is the usual time waste is subjected to immersion, not to mention the labor incident to cleaning waste by hand. Without doubt, the packing is decidedly cleaner and the oil penetration is better. By concentrating this work into fewer plants of greater capacity a large number of small obsolescent plants were abandoned. Aside from the improved mechanical features mentioned, this concentration alone insures both economy and uniformity of practice.

A substantial saving is possible due to the greater percentage of oil and waste reclaimed. The extravagant use of material is minimized if not entirely eliminated by this procedure. Wasteful practices are more difficult to correct, where packing is prepared at numerous points. It is evident that packing indiscriminately made is not always properly drained nor is all old packing accounted for. It is often left in train yards, thrown in outbound cars, used in firing locomotives or otherwise discarded. This process also precludes the use of free oil which is an expensive factor in lubrication.

Considerable discussion has ensued with respect to conditions contributing to hot boxes and the proper method of packing boxes. The causes are generally understood, and there is but a slight divergence of opinion concerning the packing of boxes. This is largely restricted to the advisability of applying a filler or plug at the front of the journal box. Reasoning on this basis, it is apparent we should then determine whether the correct practices are followed. Have we assured ourselves that inspection forces are sufficiently alert in their efforts to discern the various defects that result in hot boxes? Are we certain that oiling forces in train yards are giving necessary service treatment to cars, and that sufficient dexterity is shown with the packing iron.

Considering the importance of the proper use of packing iron, it is surprising how frequently this attention is neglected. I am inclined to believe that few railroads have standard packing irons and packing hooks, as is evidenced by the miscellaneous assortment in use. Many of these are of such dimensions and construction as to prevent oilers from obtaining best results. A satisfactory means of fixing individual responsibility for improperly packed boxes is to assign to each oiler a symbol number with alphabetical prefix to designate terminal or division and require him to mark this symbol on both sides of the car when he has given service treatment or repacked boxes. If trouble subsequently develops at any point on the railroad, it is possible to place responsibility with the oiler at fault.

It is conceded that cars ordinarily do not remain in train yards for a period sufficient to make a thorough inspection of the packing in all boxes. In view of this condition, it behooves us to give thorough attention to cars when on repair tracks where facilities are available. In such instances, the packing should be entirely removed and all boxes repacked at designated intervals. The necessity of complying with the practice cannot be too forcibly emphasized, and if the railroads will actively pursue a program of this kind an appreciable reduction in the number of hot boxes will be made.

During the time the car is on the repair track, reasonable measures should be taken with respect to the mechanical conditions that contribute to hot boxes. Trucks should be in proper alignment, journal boxes parallel and not unduly worn, tops of boxes free from irregular surfaces, dirt and grit, broken or missing truck springs should be replaced and wedges should not be distorted or otherwise defective. When wheels are exchanged compound should be removed thoroughly from all journals and the boxes cleaned carefully. Due care should also be exercised in removing worn truck pedestals on passenger cars.

The best results are not obtainable when relined journal bearings are used on passenger cars. The periodical jacking of boxes on passenger cars for examining journal bearings, wedges and journals, is advisable and in my opinion necessary to the successful operation of passenger trains. Our practice is to inspect every passenger car in this manner at three months' intervals. The expense thus incurred is promptly offset by the reduction in cost of caring for hot boxes.

The Falk-Bibby Flexible Coupling

Reference was made in the article descriptive of the Baldwin oil-electric locomotive, published in the November issue of Railway and Locomotive Engineering, to the Falk-Bibby flexible coupling that is used to connect the engine and generator shafts of that machine.

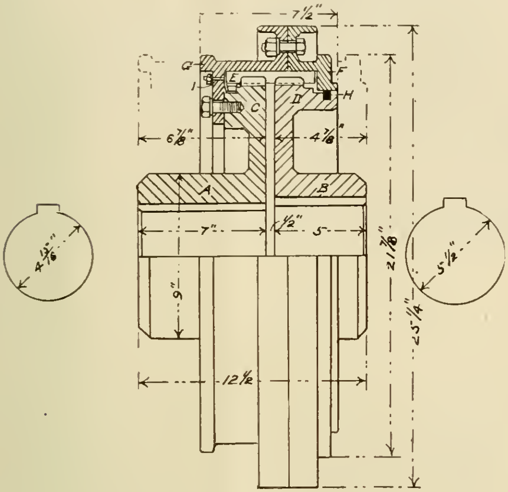
Falk-Bibby Flexible Coupling

A section of the coupling there used, and a view of a smaller size with the covering sleeve removed as made by the Falk Corporation of Milwaukee, Wisconsin, is here shown.

The coupling is formed of two flanges, *A* and *B*, similar to an ordinary flange coupling that are keyed, in the usual way to the two shafts, except that, in this case, the outer edges of the flanges are provided with lips or ledges *C* and *D*, which are cut with grooves of a peculiar shape to receive the springs by which the two parts are attached together, and by which the flexibility is attained.

The spring is the flexible member and its shape and that of the grooves, form the characteristic features of the coupling. The grooves in the disc widen inwardly toward each other, so that the spring fits closely in them only at their outer ends. This widening of the grooves is in the form of an arc of definite radius and is produced by the special machines that are used in manufacturing the coupling. The radius of the arc is made to bear a definite relationship to the thickness of the spring bars, and is so designed that, when each bar is bent around this radius the stress cannot exceed its limit of elasticity.

Under light and normal loads, there is a long and free span of spring between the points of support on the two flanges, which allows for considerable flexibility; but, under heavy overloads, the springs become supported along the sides of the grooves, thereby automatically shortening the span and stiffening the spring without increasing the stress. Under extreme overloads the springs are supported at their inner ends, and are then in shear and capable of resisting many times the load for which the coupling is designed.



Details of Falk-Bibby Flexible Coupling

The springs are shown in the section at E and are protected by a casing formed of the two pieces F and G which are held together by bolts and are themselves fastened to one of the flanges by top screws as indicated.

The whole is thus made readily accessible for inspection. The holding bolts may be released and the two parts of the casing moved back to the positions indicated by the dotted lines. This exposes the springs to view for their whole length and they can be readily removed.

As lubrication is essential to the operation of the coupling, it is provided by filling the interior of the casing with a grease (a graphite grease is preferred) so that the springs are surrounded by it. This may be done by forcing it in at the hole I which is closed by a plug. The casing, which rests against a packing H in one flange and is bolted against a finished surface on the other, is arranged so as to retain the lubricant indefinitely, while the centrifugal action insures its even distribution over the springs.

The two faces of the coupling and, with them, the ends of the two shafts are set ½ in. apart, so that there is an opportunity for some angular displacement to take place between them.

In the case of the coupling here illustrated in section, as used upon the Baldwin oil-electric locomotive, the coupling is designed to transmit 1,000 horsepower at 1,150 revolutions per minute. This means that the total load on the springs will be a little less than 7,000 lbs. And this it is carrying under the variable conditions of switching service in which the locomotive is operating.

Motor Vehicle Competition Not Cause of Abandoned Railway Mileage

In a recent study of the circumstances under which railroad mileage has been abandoned between 1920 and May 1, 1925, the Bureau of Public Roads of the United States Department of Agriculture found that less than 5 per cent of the abandoned mileage was due to the competition of motor vehicles. Exhaustion of the natural resources which contributed the bulk of traffic accounted for almost 58 per cent and competition of other railroads for almost 30 per cent. The report was made by Henry R. Trumbower, economist of the Bureau of Public Roads. The following table summarizes the primary causes of the lack of traffic which led to the abandonments:

PRIMARY CAUSES OF LACK OF TRAFFIC

Cause	Number of railroads	Percentage of number	Length Miles	Percentage of length
Exhaustion of natural resources..	78	65.0	1,411.20	57.8
Competition of other railroads....	14	11.7	713.34	29.3
Competition of motor vehicles....	10	8.4	104.46	4.3
Rearrangement of lines of railroad	5	4.1	32.64	1.3
Miscellaneous	13	10.8	177.31	7.3
Total	120	100.0	2,438.95	100.0

The report said in part:

"The causes leading to the abandonment of this railroad mileage are in some instances simple and easily determined; in other instances the causes are more or less complicated. The lack of sufficient traffic to continue making the operation profitable or even possible is the fundamental reason for abandonment. The causes for the lack of traffic are varied. The primary causes cited are: (1) Exhaustion of natural resources; (2) competition of other railroads; (3) competition of motor vehicles operating on highways; (4) rearrangement of lines of railroad; and (5) miscellaneous causes.

"Although, as has been shown, the Interstate Commerce Commission has authorized the abandonment of a large railroad mileage in the last five years, it should be borne in mind also that during this same period certificates of public convenience and necessity were issued by the Commission authorizing the new construction of 2,673.36 miles of railroad. This involved the construction of 17 lines aggregating 1,159.52 miles and 67 branches aggregating 1,513.84 miles.

"It is generally believed that highway transportation will be considered an important element in the future railroad development of the country. Highway transportation may make it necessary to make railroad extensions into certain territories and it will also make it possible to relinquish the operation of certain low-traffic lines and branches, thus saving money for the railroads and providing the public with reasonably adequate transportation service."

Oil-Electric Locomotive in Chicago

The oil-electric locomotive, which has been introduced for switching service by six of the railroads in New York City, has now been added to the equipment of one of the railroads in Chicago. The Chicago and Northwestern Railway is obtaining one of the 60-ton locomotives for service in its Chicago yards.

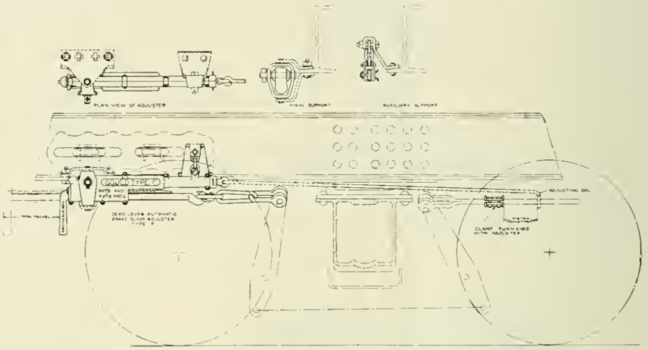
The locomotive, produced jointly by the Ingersoll-Rand, American Locomotive and General Electric Companies, is like the units which are being suppiled the Central Railroad of New Jersey, the Delaware, Lackawanna and Western, the Baltimore and Ohio, the Lehigh Valley, and the Erie for service in New York. The Long Island Railroad is obtaining a 100-ton unit for similar service.

Gould Automatic Brake Slack Adjuster for Freight Equipment Type "F"

While the modern Air Brake is one of the most highly developed and efficient devices used on freight cars, every part from the brake shoes to the brake cylinders must be in accurate adjustment for smooth and efficient braking of the long trains in use today. Varying slack on the different cars in the train, due to wear of brake shoe and wheels and wear of pins and holes in the brake rigging, results in different piston travel on each car and irregular braking action throughout the train. This irregular braking action is the principal cause of break-in-twos and damage to cars and lading due to avoidable rough handling.

Some success has attended efforts to develop an automatic slack adjuster or take-up for passenger equipment but the problem of developing a similar device for freight cars has presented more difficulty because of the limitation of cost and the necessity for accessibility without interference with other parts.

The Gould Coupler Company, which manufactures a very successful line of slack adjusters for city and interurban cars, has spent a number of years in the development of a simple and efficient device for freight equipment and The Symington Company now presents the result of this study and development in the Type "F" Freight Slack Adjuster illustrated and described herein.



An Application of the Gould Slack Adjuster to a Centre Sill

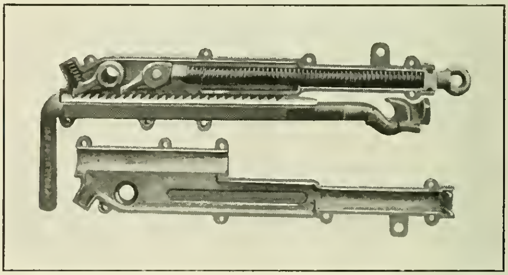
The line drawing shows a typical application to the center sill and photographs show the device in operating positions and partly disassembled to show the contained parts.

This adjuster automatically takes up wear in shoes, wheels, pins, and pin holes keeping the piston travel within approximately ½" of normal from the application of new shoes until they are worn out. When replacement of one or more shoes is necessary, the adjuster may be manually set back for this purpose, and upon the next application of the air, the device is automatically brought into proper adjustment. It is not necessary for the maintenance gang to make any calculations to determine the correct setting of the device as it is not possible to set it improperly.

This adjuster takes the place of the usual dead lever stop. It is attached to the bottom flange of one center sill by two simple forged brackets designed to allow the necessary flexibility so that the adjuster will accommodate itself to all normal movement of the dead lever on straight and curved track.

The adjuster consists of a malleable iron housing which serves as a guide for a cylindrical holding rod, the latter being flexibly connected to the dead lever. This holding rod is itself held in position by a sliding rack strip which in turn is held by a pawl or dog. Mounted in the casing above the holding rod is an adjusting rod having a dog or pawl also engaging the holding rod rack strip and held in its normal position by the spring which encircles the adjusting rod. Attached to the eye at the rear of the adjusting rod is a connection which passes under the body bolster and is slidably attached to the top connection or pull rod of the brake rigging just beyond the live lever. An adjustable stop clamped to the top connection or pull rod actuates the adjusting rod as soon as any wear has developed or as soon as the cylinder push rod moves more than the predetermined amount. Assuming wear to have taken place, an application of the brakes moves the adjusting rod so that the movable pawl picks up one tooth on the holding rod rack strip. On release of the brakes the spring returns the adjusting rod to its normal position carrying the holding rod with it and the holding rod is maintained in its new position by its engaging pawl. This operation is repeated as soon as additional wear amounts to the equivalent of one tooth space on the ratchet. In effect, the device is a dead lever stop with an infinite number of adjusting holes which automatically changes the position of the dead lever pin until the shoes are worn out.

When it becomes necessary to replace one or more shoes, the device is set back to normal by giving the drop handle a quarter turn which releases both pawls and allows the holding rod to return to the starting point. If through inadvertence the operator should fail to move the handle



The Contained Parts of the Gould Automatic Brake Slack Adjuster

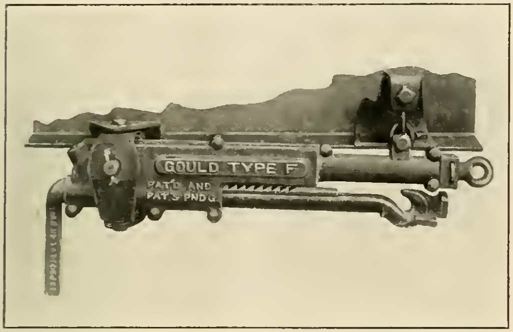
also to its original position, the first brake application will automatically do this.

The adjuster has been in service for a sufficient length of time to demonstrate its effectiveness and reliability.

The value which the men who are responsible for the handling of trains place upon a proper adjustment of the foundation brake rigging is clearly set forth in the report of the committee to the Traveling Engineers' Association that was published in the October issue of Railway & Locomotive Engineering, in which that committee called attention to a table showing the variations in piston travel. Such a table was published in considerable detail in Railway & Locomotive Engineering for March, 1922.

After referring to this table the committee went on to say that:

"The committee feels safe in saying that the fundamental enemies of the modern air brake are uneven piston travel and leaks. Uneven piston travel causes a variation in every operation of the air brake system so far as the development of power is concerned.



A Slack Adjuster for Freight Cars Which Takes the Place of the Usual Dead Lever Stop

"The variation of time required to obtain the braking power expected to be developed from a given brake pipe reduction makes it possible to obtain several times the braking power on one car as compared with another car or the percentage of braking power to be developed from the design for a given brake pipe reduction, and causes too much braking power on some cars and too little power on other cars, which will cause shocks and jars that will damage the equipment and lading."

These expressions are quoted merely to show the importance that is attached to the maintenance of a proper adjustment of the foundation rigging and with it that of the piston travel in the cylinders.

A Heat Treatment Disc

The Central Steel Co. of Massillon, Ohio, are distributing a combination disc that gives, at a glance, the proper heat treatment for twenty-one grades of steel which it manufacturers; and there are fifteen methods of heat treatment that are prescribed. In addition to this there is a table for the determination of the degree of hardness on the Brinell scale from the diameter of the impression. The diameters given start at 2.40 millimeters (.09 in.) and rise by increments of .05 millimeter (.002 in.) to 4.30 millimeters and thence by .10 millimeter to 6 millimeters. This covers a range of hardness from 652 down to 95 of the Brinell scale.

The temperatures of heating and drawing colors are also given.

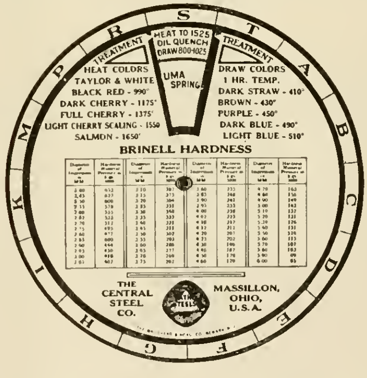
The steels for which heat treatments are given are the five grades of U. M. A. steels made by the Central Steel Co.; the U. M. A. springs, the nickel molybdenum (Ni. Moly.) and fifteen grades made in accordance with the specifications of the Society of Automotive Engineers. There are three discs in the combination, so arranged that either of the outer discs may be turned to occupy any position relatively to the central one. The central disc is the largest of the three and carries on that position which projects beyond the outer ones, the names of the steels on one side and a letter indicating the heat treatment to be used on the other.

There are five grades of U. M. A. steels and the U. M. A. springs. U. M. A. is a trade name built up from the initial letters of the three purifying elements used in the manufacture, namely: uranium, magnesium and aluminum. The steels made according to the specifications of the Society of Automotive Engineers are indicated by the

initials (S. A. E.) of that society, followed by the number of the specification.

The method of using the disc is as follows: Set the open segment of the disc beneath the grade of steel to be treated. In the case of the illustration it is set beneath the U. M. A. spring steel. The opening shows the steel to contain from 1.00 to 1.20 per cent. of chromium; from .47 to .52 per cent. of carbon; from .80 to 1.00 per cent. of manganese and that it is to be given the S treatment.

Turning the disc over and setting the notch of the other



outer disc under the S, we have the instructions to heat to 1,525 degrees Fahr., oil quench and draw to from 800 to 1,025 degrees Fahr.

The diameter of the large disc is 3⅜ in., and the whole is made of celluloid.

Locomotive Inspection Report

The Bureau of Locomotive Inspection of the Interstate Commerce Commission in October inspected 8,257 locomotives, of which 3,508 were found defective and 342 were ordered out of service, according to the commission's monthly report to the President on the condition of railroad equipment.

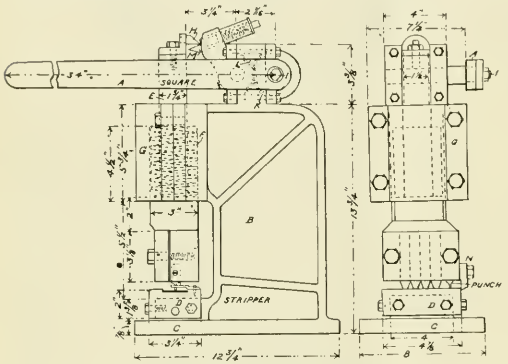
Shop Kinks

A Tag-Stamping Machine in Use on the Delaware & Hudson Company

It is in the custom in the shops of the Delaware & Hudson Co., at Watervliet, New York, to attach a tin tag to each part of a dismantled locomotive for the purpose of later identification. Formerly the preparation of these tags occupied about all the time of one man, as several hundred tags were required for each engine going through the shop for general repairs.

Where an engine number consisted of four figures, the use of four stencils, and a punch for punching the wire hole, besides the cutting of the tags to length involved a good deal of labor.

In order to avoid this as well as the delay that frequently occurred in the preparation of the tags, Mr. John E. Foley, the foreman of the tool room, designed the little machine that is shown in the accompanying drawing. It is



Details of Tag-Stamping Machine Used on the Delaware & Hudson

so arranged that with a single stroke of the operating lever *A* the tag is stamped with the engine number, the hole is punched for the fastening wire and the tag is cut off from a strip of tin to the proper length.

The base *B* is of cast iron, and is provided with a lip *C* at the bottom to which the steel anvil block *D* is bolted. The front face is finished to receive the plunger *E* and the spring *F* both of which are held in place by the cap *G*.

The lip *H* is attached to the upper end of the plunger.

The operating lever *A* is pivoted at *I* and the shaft to which it is attacked has the segment of a gear *K* fastened to it. This meshes with another segment *L* forming part of a short lever in the end of which the trigger *M* is inserted. This is held out by the spring shown in the casing surrounding its stem.

When the operating lever is raised the beveled edge of the trigger strikes the corresponding edge on the top of the lip *H* and it is pushed back by the compression of its holding spring. When the lever has been raised sufficiently the two edges of the trigger and the lip slip past each other and the trigger is thrown forward into the engaging position shown in the engraving.

Then, if the operating lever is depressed, the trigger lifts the lip and with it the plunger, compressing the spring *F* which has a bearing on a shoulder of the plunger. At a certain point the trigger slips off from the lip, releasing it and the plunger, when the spring forces the latter down striking a blow on the strip of tin on the anvil.

At its lower end the plunger is fitted with a shear blade *N* for cutting the tag off from the strip from which it is made, and its bottom has a socket capable of holding four ½-in. steel stencils and a punch. So that, at each stroke of the plunger a tag is produced bearing the engine number, a hole for the fastening wire and it is cut off to the proper length.

Instead of one man being employed almost constantly in the preparation of these tags, the attendant at the tool room window makes all of the tags required, during his leisure moments, and so rapidly is the work done that even these are not fully occupied.

Condition of Railway Equipment

Although freight traffic measured by the number of cars loaded with revenue freight has so far this year been the heaviest ever handled by the railroads, Class I railroads on November 1 had fewer freight cars in need of repair than at any time since February, 1924, and fewer locomotives in need of repair than at any time since the last half of December, 1923.

The number of freight cars in need of repair on November 1 was 165,481, or 7.1 per cent of the number on line. This was a decrease of 8,725 under the number on October 15 and 25,062 cars under the number in need of repair on November 1, last year, at which time there were 190,543 or 8.2 per cent.

Freight cars in need of heavy repair on November 1 totaled 127,680 or 5.5 per cent, a decrease of 8,102 compared with October 15. Freight cars in need of light repair totaled 37,801, or 1.6 per cent, a decrease of 623 compared with October 15.

Locomotives in need of repair on November 1 totaled 10,233 or 16.1 per cent of the number on line. This was a decrease of 689 locomotives compared with October 15 when there were 10,922 or 17.1 per cent and a decrease of 862 compared with the number in need of repair on November 1, last year.

Of the total number in need of repair on November 1st, 5,387 or 8.5 per cent were in need of classified repairs, a decrease of 366 compared with October 15, while 4,846 or 7.6 per cent were in need of running repairs, a decrease of 323 locomotives within the same period.

Class I railroads had 4,450 serviceable locomotives in storage on November 1, a decrease of 371 compared with the number of such locomotives on October 15.

Equipment Placed in Service

Class I railroads during the first ten months this year placed in service 119,243 freight cars, according to reports filed by the carriers with the Car Service Division of the American Railway Association.

This was a decrease of 18,126 under the number installed during the corresponding period last year and 36,629 less than during the same period in 1923.

Of the total number installed during the ten-month period this year, 5,428 were placed in service during the month of October, including 2,086 box cars, 1,670 coal cars and 465 refrigerator cars.

Freight cars on order on November 1 this year totaled 24,606 compared with 40,760 on the same date last year and 48,571 in 1923.

Snap Shots — By the Wanderer

It is not so many years ago that it was quite impossible, and it is no easy task even now, to convince the holders of a railroad's purse strings, that there was such a thing as an obsolete locomotive or machine tool, especially a machine tool. Won't the locomotive haul just as much as ever and the tool take just as big and fast a cut as ever? Of course it will, but—, "Well then what do you want to scrap them for?" comes back as a quick query.

Sometimes, however, the rapidity with which things become obsolete in these days of rapid movement, almost takes the breath out of a man who is struggling hard to keep in sight of the procession and who thinks it is not so very far ahead of him even though it may be out of sight.

For example, it was only a few days ago that I was talking with a manufacturer who is a builder of a high grade machine tool, with sales agents all over the world. Speaking of his own tools, he placed seven years as the limit of their profitable life, because of inevitable obsolescence, and at the age of ten or eleven years, they become an economical menace even though they may have been kept in as good physical condition as when new. This was stated with all of the matter-of-fact assurance that he would have commented on the brightness of the sunshine.

I don't suppose that this holds good of all classes of machine tools, but that it holds for any is startling enough.

As, for locomotives, well! It is breathless work trying to keep posted on what is being done. We are forever thinking that we have about the best that there can be, only to be brought up with a sharp realization that we are woefully behind the times.

Take the developments of the past five or six years in locomotive designing as an instance. We would hardly want to go back to the designs of 1919 for the best that can be produced. And the question is as to whether it would be more economical to scrap those six-year olds or keep them at work. Not that there is much chance of those youngsters being scrapped, but we can at least suggest it as a problem in economics.

Here are two cases taken from life.

My friend Thompson is something of a hustler and can frequently give the machine shop a pointer. He represents and has an interest in a machine shop about a hundred miles from his place of business. A few days ago he wrote for an estimate on a certain piece of work upon which he wished to bid. When it came, it was so high that he knew he didn't have the ghost of a chance to secure the contract. So he began to figure and think, with the result that, in forty-eight hours he put in a bid for just one-half of the amount that the shop estimate called for.

Oh, yes, he had to put in some new improved machinery, but the profits on the first order paid for that with a nice little margin over and above. This is quoted to show that, when the time comes, a man must be able to tell whether new machinery is worth while and will pay for itself, and whether a little enlargement will be beneficial or not. A great many shops lose work because the owner cannot think quickly enough to take advantage of an offered opportunity, just as many railroad shops are expensive luxuries because the controlling official will not let the shop superintendent think for him. Which is just the quality that makes the difference between a success and a lack of it.

I am not quite sure that I have not told the other story before. But if I have it is so long ago that I may presume that you have forgotten it.

It happened at a time when the American type of eight-wheeler was just beginning to lose its grip as the all around locomotive for freight and passenger service, on the railroads of the country. There was a certain big trunk line that was dominated by a man in the confidence of the owner, who believed in letting well enough alone, and who thought that what had been good enough for the past was good enough for the future. So while the mogul and the consolidation had begun to get a foothold elsewhere, the eight wheeler continued as the sole representative of advanced motive power on this great trunk line. Naturally outsiders held the superintendent of motive power responsible for this state of affairs, and I was among the number.

I once said to an officer of the company that I thought it strange Mr. A—, the superintendent of motive power, that, being a man of such sound horse sense, he should continue to use these light engines when everybody else was going to the heavier weights, and that his action was probably costing his road millions of dollars.

"Well," said my friend, "if you were in his place and had gone to the management time and again, with the suggestion that a heavier locomotive be bought and had been asked how much it would cost and had said $12,500.00 and that the present type cost only $11,000.00, but that the heavier one would save its extra cost in the first six months, and had then been told to go ahead and buy the $11,000.00 engine, because that would avoid the necessity of saving that $1,500.00, the time would come when you would cease to make any recommendations."

So the great trunk line continued to use the light locomotives until the dominating figure holding the confidence of the owner went the way of all flesh and fresh blood began an era of discard and replacement. This was, of course, an extreme case and is but an exemplification of what a blindness to evident obsolescence can achieve.

It is a serious and important matter to decide as to when expensive machinery shall be declared to be junk, and it takes a bold man, at times, to act, and, to take you into my confidence, dear reader, I am rather glad that the final decision so rarely rests upon my shoulders, for it is so much easier to preach about the common sense of discarding the obsolete, than it is to take the responsibility of selling the article for junk.

The railroad societies, clubs and associations, of this country are probably responsible for more valuable practical technical literature than the kindred associations of all of the remainder of the world beside. That is a purely personal belief, based on some observation, checked by conversation with others. But there are some cases when it does seem as though individual items of this literature had been terribly handicapped by their presentation. It seems to be a human failing to believe, "I am right," and "I know how," in total disregard of how others see us.

I do not know whether he ever made a formal suggestion to that effect, but the late M. M. Forney, was wont to urge, in his conversations, the advisability of having a regularly paid presiding officer for the big and little associations—a man who had a good speaking voice, and a familiarity with parliamentary forms, and could handle an assembly with correct skill. Then for the honor of the thing, there should be a duly elected president. I do not suppose that he ever thought the thing would be done, and it probably will not, but then, like most of his ideas, it does seem good.

As for the papers there are two things to be considered. First, the preparation for the printed page where everything should be set down for the full information of the searcher after the ultimate facts. Second, the presentation to an audience that must get the gist of the paper through the ears, where repetition and study is impossible, and where the attention must be held from second to second, else it becomes dull and tiresome. It is very difficult for a man to remember that his baby is not as interesting to others as it is to himself, and that the long array of tables and figures that he has spent days in preparing cannot be grasped in as many minutes by a listening audience.

I sometimes think that it would be well for each club to have a proctor who would give the presenter of each paper regular instructions as to what the audience can absorb.

And above all drive home the necessity for a clear and moderately rapid enunciation.

All of which was suggested by some recent experiences where skilled men tried their audience by a long sequence of figures and an enunciation that was almost impossible to understand. We can, as I have said, be justly proud of the subject matter of the papers presented to our railroad clubs and societies, but must acknowledge that, at times, there has been much left to be desired in the method and substance of their presentation.

Notes on Domestic Railroads

Locomotives

The Erie Railroad has placed an order for one oil-electric locomotive with the American Locomotive Company, The General Electric Company, and the Ingersoll-Rand Company.

The Missouri Pacific Railroad has ordered 10 Santa Fe type locomotives from the Baldwin Locomotive Works.

The Atlantic Coast Line Railroad has ordered 30 Pacific type locomotives, 5 Santa Fe type locomotives, 10 eight-wheel switching locomotives and 8 six-wheel switching locomotives from the Baldwin Locomotive Works.

The Detroit Terminal Railroad is inquiring for 3 eight-wheel switching locomotives.

The Norfolk & Western Railway will build 10 Mountain type passenger type locomotives in its own shops at Roanoke, Va.

The Denver & Rio Grande Western Railroad has ordered 10 Mountain type locomotives from the Baldwin Locomotive Works.

The Consolidated Railroad of Cuba has ordered 6 Mikado type locomotives from the Baldwin Locomotive Works.

The Chile Exploration Company has ordered 13 electric locomotives from the Westinghouse Electric International Company.

The Delaware, Lackawanna & Western Railroad has ordered 2, 60-ton oil-electric locomotives from the American Locomotive Company, the General Electric Co. and the Ingersoll-Rand Company.

The Chesapeake & Ohio Railway has placed a contract for the rebuilding of 10 locomotives with the Newport News Shipbuilding & Drydock Company.

The St. Louis-San Francisco Railway is inquiring for 15 Mikado type locomotives and 10 Mountain type locomotives.

The Wabash Railway is inquiring for 25 eight-wheel switching locomotives.

The Delaware, Lackawanna & Western Railroad is inquiring for one electric freight locomotive to be used in the Brooklyn yards.

The Missouri Pacific Railroad it is reported will build 15 switching locomotives in its own shops.

The Guayaquil & Quito has ordered 2 Consolidation type locomotives from the Baldwin Locomotive Works.

The Norfolk Southern Railroad is inquiring for 5 Consolidation type locomotives.

The New York, New Haven & Hartford Railway has ordered 10 heavy locomotives from the American Locomotive Company.

The Hokkaida Railway has ordered 3 Mogul type locomotives from the Baldwin Locomotive Works.

The Central of Georgia Railway has placed orders for 5 Mountain type locomotives with the Baldwin Locomotive Works.

The Tennessee Central Railroad has ordered 4 Mountain type locomotives from the American Locomotive Company.

Passenger Cars

The New York Central Railroad is inquiring for 25 steel coaches 25 baggage-mail cars, 20 dining cars, 20 milk cars and 9 passenger-baggage cars.

The Wabash Railway is inquiring for 20 baggage cars.

The St. Louis-San Francisco Railway has ordered 14 coaches from the American Car & Foundry Company.

The Erie Railroad has placed orders for 2 passenger-baggage gasoline rail motor cars and 3 passenger baggage gasoline electric rail motor cars with the J. G. Brill Company, Philadelphia, Pa.

The National Railway of Mexico are inquiring for 5 baggage-mail cars.

The Delaware, Lackawanna & Western Railroad is inquiring for 35 steel express cars, 40 scteel milk cars, 2 dining cars and 2 postal cars.

The Atchison Topeka & Santa Fe Railway is inquiring for 5 cafe-observation cars.

The Texas & New Orleans Railroad is inquiring for 6 coaches and 3 baggage cars.

The Delaware, Lackawanna & Western Railroad has ordered 2 postal cars from the American Car & Foundry Company.

The Chicago, Milwaukee & St. Paul Railway is inquiring for 770 12 passenger car underframes.

The Chesapeake & Ohio Railway has ordered 3 postal cars from the Bethlehem Shipbuilding Corporation.

The Norfolk & Western Railway is inquiring for 18 coaches, 6 combination passenger and baggage cars, 4 combination baggage-mail cars and 15 baggage express cars.

The Atlantic Coast Line Railroad is inquiring for 30 express cars, 25 coaches, 10 combination passenger and baggage cars, 4 combination baggage-mail cars and 2 postal cars.

The Erie Railroad has ordered 50 suburban coaches and 18 line coaches from the Standard Steel Car Company.

The Temiskaming & Northern Railway has ordered 3 first class coaches, 3 second class coaches, and 3 baggage cars from the National Car Corporation.

Freight Cars

The Great Northern Railway has ordered 1,000 steel underframes for freight cars from the Siems Stembel Company.

The Atchison Topeka & Santa Fe Railway has ordered 500 refrigerator cars from the American Car & Foundry Company and 500 from the Pullman Car & Manufacturing Co.

The Southern Railway has ordered 100 caboose cars from the Lenoir Car Works.

The Denver & Rio Grande Western Railroad has ordered 500 gondola cars from the Western Steel Car Company and 250 automobile cars from the Mt. Vernon Car & Mfg. Co.

The New York Central Railroad is inquiring for 1,000 hopper cars of 35 tons capacity.

The Delaware, Lackawanna & Western Railroad is inquiring for 25, 8-wheel caboose cars and 50 ballast cars.

The Palace Poultry Car Company has ordered 50 live poultry cars from the Illinois Car & Manufacturing Co.

The Reading Company is inquiring for 1,000 gondola cars of 70 tons capacity.

The Lehigh Valley Railroad is inquiring for 500, 70-ton hopper cars.

The Pennsylvania Railroad has placed an order with the Standard Tank Car Company for repairs to 500 hopper cars.

The Pacific Fruit Express is inquiring for 5,000 refrigerator cars.

The Chicago, Milwaukee & St. Paul Railway is inquiring for coal car bodies.

The Wabash Railway is inquiring for an additional 1,000 single sheathed automobile cars.

The Atlantic Coast Line Railroad is inquiring for 525 single sheathed box cars of 40 tons capacity, 300 coal cars and 100 ballast cars.

The Consolidated Railroads of Cuba have ordered 200 box cars and 50 stock cars from the American Car & Foundry Company.

The Missouri Pacific Railroad has placed orders for 3,000 cars as follows: 1,000 box cars, 250 hopper cars and 250 automobile cars with the American Car & Foundry Company, 500 box cars and 250 automobile cars with the Standard Tank Car Company, 500 box cars with the General American Car Company and 250 stock cars with the Pennsylvania Tank Car Company.

The Lehigh Valley Railroad is inquiring for 500 single sheathed 50-ton automobile cars.

The Premier Red Ash Coal Company has ordered 60 mine cars from the American Car & Foundry Company.

The New York Central Railroad has placed orders for 4,500 cars as follows: 1,000 gondola cars with the Pullman Car & Manufacturing Company, 1,500 box cars with the American Car & Foundry Company, 1,000 gondola cars with the General American Car Company, 500 gondola cars with the Tennessee Coal & Iron Railroad Company and 500 gondola cars with the Illinois Car & Manufacturnig Company.

The Sun Oil Company has ordered 100, 6,500 gallon tank cars from the Standard Tank Car Company.

The International Railway of Central America are inquiring for 10 tank cars.

The Atchison Topeka & Santa Fe Railway is inquiring for 3,000 cars as follows: 1,000 refrigerator cars, 850, 50 ton coal cars, 150 70 ton gondola cars, 500 automobile cars and 500 box cars.

The Chicago Burlington & Quincy Railroad has ordered 16 tie cars from the American Car & Foundry Company.

The Buck Mountain Coal Company has ordered 20 mine cars from the American Car & Foundry Company.

The Atlanta & West Point Railroad has ordered 250 box cars from the Tennessee Coal, Iron & Railroad Company.

The St. Louis-San Francisco Railway has placed orders for 4,000 cars as follows: 2,000 box cars from the American Car & Foundry Company, 500 box cars from the General American Car Company, 500 automobile cars from the Pullman Car & Manufacturing Company, 500 automobile cars from the Mt. Vernon Car & Manufacturing Company, 500 gondola cars with the Tennessee Coal, Iron & Railroad Company.

The New York, Chicago & St. Louis Railway has placed an order for 100 underframes with the Pennsylvania Car Company.

The Conley Tank Car Company is inquiring for 200, 40 ton tank cars.

The Birmingham Southern Railway is inquiring for 100 70 ton gondola cars.

The St. Louis Southwestern Railroad is inquiring for 500 box car underframes.

Buildings and Structures

The Central Railroad of New Jersey plans the construction of car and locomotive repair shops at Bethlehem, Pa., to cost about $2,000,000.

The Kentucky & Indiana Terminal Railroad has placed a contract covering the construction of a shop building, storehouse and office building at Louisville, Ky.

The St. Louis Southwestern Railway plans to spend approximately $130,000 for enlarging and modernizing its shops at Pine Bluff, Arkansas.

The Grand Trunk Railway plans the construction of an engine house and machine shop at Pontiac, Mich., to cost approximately $1,400,000.

The Pennsylvania Railroad plans the construction of additions to its shops at Olean, New York, to cost approximately $218,000.

The Reading Company plans a storage and distributing plant at Pottstown, Pa., to cost approximately $100,000.

The Wabash Railway has placed a contract for a coaling station at St. Louis, Mo., with the Roberts & Schaefer Company, Chicago, Ill., to cost $35,000.

The Great Northern Railway has awarded a contract for the construction of a two-story bus garage and machine shop at Minneapolis, Minn.

The Southern Pacific Company plans the construction of a new classification and switching yard at Fresno, Calif., at a cost of approximately $650,000.

The Chicago Junction Railway has awarded a contract covering the construction of an office building at Chicago, Ill., to cost approximately $25,000.

The Chicago, North Shore & Milwaukee Railroad plans have been prepared for the construction of a motor bus terminal at Libertyville, Ill., to cost $40,000.

The Baltimore & Ohio Railroad has awarded a contract for the construction of a water treating plant at De Forest Junction, Ohio, to Joseph E. Nelson & Sons, Chicago, Ill., to cost approximately $18,000.

The Lehigh Valley Railroad plans the enlarging of its enginehouse and shops at Easton, Pa.

The New York Central Railroad plans the construction of shop buildings and a freight terminal at Yonkers, New York, to cost approximately $500,000.

The Louisville & Nashville Railroad plans the construction of a pumping station in its yards at Memphis, Tenn., to cost approximately $20,000.

The Atchison, Topeka & Santa Fe Railway plans the construction of four small buildings and alterations to other buildings at Bakersfield, Calif.

The Pennsylvania Railroad has announced that it plans an expenditure of $15,000,000 for improvements in the Pittsburgh district, together with other large expenditures at various points on the line.

The Savannah & Atlantic Railway has placed an order covering the construction of a coaling station at Sardis, Ga.

The Oneida & Western Railroad has placed a contract for rebuilding its shop and power house at Oneida, Tenn., which was recently destroyed by fire.

The Chicago, Rock Island & Pacific Railway has awarded contract covering the construction of an enginehouse at Dalhart, Texas, to cost approximately $100,000.

The Chesapeake & Ohio Railway has placed a contract covering the erection of a coaling plant at Olive Hill, Ky., with the T. W. Snow Construction Company, Chicago, Ill.

The Missouri-Kansas-Texas Railroad plans an additional unit in the car shops at Dennison, Texas. It will cost approximately $130,000, including equipment.

The Chicago & North Western Railway plans the construction of a car wheel shop at Winona, Minn., to cost approximately $35,000.

Items of Personal Interest

James T. Gillick, formerly general manager of the Eastern division of the Chicago, Milwaukee & St. Paul Railway, with headquarters at Chicago, Ill., has been appointed chief operating officer, with the same headquarters, succeeding **B. B. Creer**, who has been elected president of the New York Air Brake Company.

F. H. McGuigan, Jr., who has been appointed engineering assistant to the executive vice-president of the Gulf Coast Lines and the International, Great Northern Railroad, with headquarters at Houston, Texas.

James Paul has been appointed assistant superintendent of motive power, third division of the Atlantic Coast Line Railroad, with headquarters at Uceta, Fla. Mr. Paul entered the service of this company in car department at Waycross, Ga., 1885, was transferred to locomotive department at Savannah, Ga., in 1886, and in 1894 was placed in charge of air brake department. He was promoted to general foreman at Savannah in 1898, and promoted to master mechanic at High Spring in 1906.

F. P. Pfahler has been appointed assistant to the chief of motive power and equipment of the Seaboard Air Line Railway, with headquarters at Savannah, Ga.

M. Meatyard has been appointed road foreman of engines of the Chicago and Alton Railroad, with headquarters at Bloomington, Ill. He will have full supervision of locomotive operation and the conservation of fuel and lubrication. **O. A. Hudson** has been appointed general roundhouse foreman, with headquarters at Roodhouse, Ill.

W. P. Kershner has been appointed master mechanic of the Kansas division of the Missouri Pacific Railroad, with headquarters at Osawatomie, Kansas, succeeding **S. L. Landis.**

J. S. Ford, formerly road foreman of locomotives of the Chicago, Burlington & Quincy Railroad, has been appointed assistant master mechanic of the Galesburg division, with headquarters at Galesburg, Ill.

F. R. Butts, formerly assistant master mechanic of the Brookfield division of the Chicago, Burlington & Quincy Railroad, with headquarters at Hannibal, Mo., has been appointed master mechanic of the division, with headquarters at Brookfield, Mo., succeeding **H. H. Urbach**, transferred.

E. H. Weigman has been appointed master car builder of the Kansas City Southern Railway, with headquarters at Pittsburg, Kansas, succeeding **J. Gutteridge**, who has been assigned to other duties.

W. R. Witherspoon has been appointed master mechanic of the Atlantic Coast Line Railroad, with headquarters at High Spring, Fla., succeeding **James Paul**, who has been appointed assistant superintendent of motive power.

A. C. Bruning has been appointed road foreman of engines of the Chicago and Alton Railroad, with headquarters at Bloomington, Ill. His territory will include Bloomington to St. Louis and Bloomington Terminal. He will have full supervision of locomotive operation and the conservation of fuel and lubrication.

J. J. Siegfried has been appointed road foreman of engines of the Chicago and Alton Railroad, with headquarters at Roodhouse, Ill. He will have full supervision of locomotive operation and the conservation of fuel and lubrication. **Glenn Salmon** has been appointed general roundhouse foreman, with headquarters at Bloomington, Ill.

Judson Zimmer has been appointed general superintendent of the Fonda Johnstown & Gloversville Railroad, with headquarters at Gloversville, N. Y.

H. C. White has been appointed superintendent of terminals of the Grand Trunk Railway, with headquarters at Port Huron, Mich., succeeding **S. L. Trusler**, retired.

C. L. Gibson has been appointed master mechanic of the Portland division of the Southern Pacific Company, with headquarters at Brooklyn, Oregon, succeeding **D. M. McLauchlan**, retired. **H. J. McCracken** has been appointed master mechanic of the Stockton division, with headquarters at Tracy, Calif., succeeding Mr. Gibson, and **A. B. Wilson** has been appointed assistant master mechanic of the western division, with headquarters at West Oakland, Calif., succeeding Mr. McCracken.

E. A. Hibbett has been appointed superintendent of the Atlanta division of the Nashville, Chattanooga & St. Louis Railway, succeeding **J. A. Baldwin**, retired.

Edward Hungerford has been appointed centenary director of the Baltimore & Ohio Railroad, and will be in charge of all arrangements, for the centennial of the company, to be celebrated in 1927.

C. H. Wright has been appointed assistant to the general superintendent of transportation of the Kansas City Southern Railway, with headquarters at Kansas City, Mo., and **C. E. McCarty** has been appointed inspector of transportation, with headquarters at Kansas City, Mo., succeeding Mr. Wright.

R. C. Reid has been appointed superintendent of the Alabama Great Southern Railroad, with headquarters at Birmingham, Alabama.

A. J. Chester has been appointed superintendent of transportation of the Texas & Pacific Railway, with headquarters at Dallas, Texas.

Supply Trade Notes

William H. Woodin, president of the **American Car & Foundry Company**, has been elected president of the **American Locomotive Company**, to succeed **Andrew Fletcher**, deceased. Mr. Woodin has been a director and member of the executive committee of the American Locomotive Company for many years.

W. E. Hedgcock, assistant vice-president in charge of sales of the **American Car & Foundry Company**, with headquarters at New York, has been elected a vice-president with duties as formerly. **Oscar B. Cintas**, vice-president of the **American Car & Foundry Export Company**, with headquarters at New York, has been elected also a vice-president of the **American Car & Foundry Company**.

George P Baldwin, general merchandising manager of the **General Electric Company**, has been elected a vice-president. Mr. Baldwin will have charge of activities connected with the electrification of the steam railroad. His new headquarters will be located at 120 Broadway, New York city.

Ray A. Sossong, manager of gas plants, **Air Reduction Sales Company**, with headquarters at New York, was elected president of the **International Acetylene Association** at the recent annual convention.

The G. M. Basford Company at a special meeting of its Board of Directors elected **Roger L. Wensley**, president and director to fill the vacancy caused by the death of G. M. Basford. Other officers and directors of the company remain the same. Mr. Wensley has been associated with the G. M. Basford Company for the past eight years, the last three of which were in the capacity of vice-president. The G. M. Basford Compay will continue the ideals and policies followed during Mr. Basford's administration.

The Davis Boring Tool Company, St. Louis, Mo., has established a branch office in Detroit and has appointed **A. J. Heaney** as mechanical engineer and **J. Mull** as sales representative in that territory.

J. H. Whiting has been elected chairman of the board of the **Whiting Corporation. Colonel T. S. Hammond**, vice-president and secretary, has been elected president and treasurer, succeeding Mr. Whiting. **R. A. Pascoe** has been appointed secretary, succeeding Colonel Hammond, **R. H. Bourne**, vice-president and sales manager, has been elected president of the **Grindle Fuel Equipment Company**, a subsidiary, succeeding Colonel Hammond, and **N. S. Lawrence**, vice-president and assistant sales manager of the Whiting Corporation has been appointed president of the **Swenson Evaporator Company**, another subsidiary of the Whiting Corporation.

J. E. Finneran, purchasing agent of the **Buckeye Steel Casting Company**, has resigned to enter other business and **T. B. Taylor**, present assistant superintendent, has been appointed director of purchases.

M. J. Carney, president of the **Prest-O-Lite Company, Inc.**, New York, has been elected chairman of the board; **William F. Barrett**, vice-president, has been elected president. **Ralph R. Browning** has been elected vice-president in charge of acetylene sales, and **R. J. Hoffman** has been elected vice-president in charge of storage battery and automotive divisions.

The Truscon Steel Company, Youngstown, Ohio, plans the construction of new buildings in that city in which to house its fireproofing department, which was recently purchased from the **General Fireproofing Company**.

F. M. Cross has been appointed manager of the pneumatic tool department of **Ingersoll-Rand Company** for the Chicago territory and will have headquarters in Chicago. Mr. Cross formerly held the same position in the New York territory.

Grant W. Lillie has been appointed sales engineer for the **Hubbard Steel Foundry Company**, East Chicago, Ind., with headquarters at the McCormick Building, Chicago, Ill.

G. W. Mead, president of the **Linde Air Product Company**, New York, has been elected chairman of the board; **William F. Barrett**, vice-president, has been elected president; **Ralph R. Browning** has been elected vice-president in charge of sales; **J. A. Rafferty**, vice-president in charge of engineering, manufacturing and research.

L. Thomas has been appointed assistant sales manager of the **General Railway Signal Company**, with headquarters at Rochester, New York.

The American Steel Foundries have arranged to dispose of their spring plant at Detroit to a company now being formed. The new company will also take over the **Eaton Axle & Spring Co.**, and, as payment for the Detroit plant, the American Steel Foundries will receive the entire issue of preferred stock of the new company.

The American Railway Appliances Company, New York City, has been appointed eastern representative of the **Premier Staybolt Company**, Pittsburgh, Pa.

W. G. Clyde has been elected president of the **Carnegie Steel Company**, succeeding **Homer D. Williams**, who has resigned to become president of the **Pittsburgh Steel Company.**

Henry T. Chandler has been appointed assistant to the president, **Vanadium Corporation of America.** Mr. Chandler has been associated with the Vanadium Corporation since January 1, 1923, in the capacity of metallurgical engineer, with headquarters in Detroit. Mr. Chandler has had an extremely wide and varied experience in the iron and steel fields, and is one of the foremost metallurgical engineers in the country.

Mr. Chandler's headquarters will continue to be at Detroit. He will, in their field, have general supervision of the development and research work in iron and steel at the plants of the Vanadium Corporation of America and its subsidiary, the **United States Ferro Alloys Corporation.**

Homer D. Williams has been elected president of the **Pittsburgh Steel Company**, succeeding **D. P. Bennett**, retired. **W. C. Reitz** has been elected treasurer, succeeding **Clayton Snyder**, and **W. L. Rowe** has been elected assistant theasurer, succeeding **C. E. Reichenbach.**

B. B. Greer, chief operating officer of the Chicago, Milwaukee & St. Paul Railway, has resigned to become president and director of the **New York Air Brake Company.**

A. C. Holden, Pacific Coast manager of the **General Railway Signal Company**, Rochester, N. Y., has been appointed resident manager of the Chicago office, with jurisdiction over the Central and Pacific Coast territories.

James M. Buick, vice-president of the **American Car & Foundry Company**, at his own request, has been relieved from the management of the sales department, a responsibility assumed six years ago. Mr. Buick, who has been connected with the company in an official capacity since its formation in 1899, will continue as vice-president, with headquarters in New York as heretofore. **Herbert W. Wolff**, who has been a vice-president since February, 1916, in charge of the Chicago district, has been appointed manager of sales, succeeding Mr. Buick, and will be located in New York.

L. F. Wilson, vice-president of the **Bird Archer Company**, with headquarters at Chicago, has been promoted to vice-president and general manager, with the same headquarters, and will have jurisdiction over production and operation, including sales and service.

E. K. Conneely, vice-president of the **New York Air Brake Company** at New York, has resigned to become vice-president of the **Pullman Company.**

Mark C. Pope, who has been connected with the **Electric Storage Battery Company**, with headquarters at Washington, D. C., for the past five years, has been promoted to manager of the Atlanta branch. Prior to his service with the Electric Storage Battery Company. Mr. Pope has served with the **General Electric Company** at Schenectady, New York, and later with the **International General Electric Company.**

Horatio S. Schroeder, general sales manager of the **Interstate Iron & Steel Company**, Chicago, has been promoted to vice-president in charge of sales.

Walter F. Mulhall, who for the past four years has been an account executive with the **G. M. Basford Company**, has been elected vice-president of this company. Mr. Mulhall before coming with the G. M. Basford Company, was assistant to the general superintendent of the **Midvale Steel Company**, then assistant to the vice-president of **Tacony Steel Company** and **Penn-Seaboard Steel Company.**

John E. Ferry, assistant to the president of the **Franklin Railway Oil Company**, Franklin, Pa., has been elected vice-president, with headquarters at Franklin, Pa.

W. F. James, manager of the industrial division of the Philadelphia district of the **Westinghouse Electric & Manufacturing Company**, has been appointed district manager, with headquarters at Philadelphia. Mr. James succeeds **H. H. Seabrook**, for the past twenty years district manager, and now assigned to special duties.

Obituary

Andrew Fletcher, president of the American Locomotive Company, died at his home in New York City of heart disease on November 29.

Mr. Fletcher has been head of the American Locomotive Company since December, 1916. He succeeded the late Waldo H. Marshall.

He was born in New York on June 8, 1864. He was educated at the College of the City of New York, later studying naval architecture and marine engineering. Among the many important contributions that he made to American marine engine manufacture was his production of the first three turbine-driven vessels launched in the United States.

Mr. Fletcher was also a director in the American Car & Foundry Company; American Locomotive Sales Corporation, of which he was president; Atlantic Gulf Corporation; Bucyrus Company; the Canadian Car & Foundry Company; Consolidated Iron Works, of which he was president; B. B. & R. Knight, Inc.; Lloyd's Register of Shipping for the United States; Montreal Locomotive Works, Ltd., of which he also was president; the Superheater Company; W. & W. Fletcher & Co. (North River Iron Works); William Cramp & Sons Ship & Engine Building Company; Richmond Locomotive Works, of which he was also president, and the North River Derrick Company. He was a member of the executive committee of the Atlantic, Gulf & West Indies Company and a trustee of the American Surety Company. He was also a member of the Society of Naval Architects and Marine Engineers, American Society of Mechanical Engineers, American Society of Naval Engineers, and the Institution of Engineers and Shipbuilders, Scotland.

Joseph G. Arn died November 23rd at the Mithoefer Hospital in Cincinnati, Ohio. He was buried at Montezuma, Indiana, the place of his birth, on November 25th. Mr. Arn was born February 17, 1866. He entered the service of the Louisville & Nashville Railroad at Louisville, Kentucky, as fireman in 1883; was promoted to engineman in 1887, and to traveling engineer in 1904. After several years as traveling engineer he resigned from L. & N. service to enter the railway supply business, representing successively the Galena Signal Oil Company, the Nathan Manufacturing Company, and the Home Oil Company. Since 1920 he had been manager of the Southeastern district for the Dearborn Chemical Company, in the railroad department.

Allen A. Tirrill, an inventor and consulting engineer of the Westinghouse Electric & Manufacturing Company, died recently at the age of 52. Mr. Tirrill was the inventor of a voltage regulator bearing his name. For many years he was associated with the General Electric Company, Schenectady, N. Y., and in 1910 became an engineer at the Westinghouse Company. He left the company in 1916, but since that time had been one of its consulting engineers. In 1897 he put in the first voltage regulators in Lakeport and Concord, N. H. Mr. Tirrill sold his patents to the General Electric Company in 1902, and in 1910 the company sent him on a tour of Europe to demonstrate the practicability of the regulator. In 1914 he was awarded the John Scott legacy medal for his meritorious invention, together with a diploma.

Robert P. Queen, superintendent of the foundry of the Mt. Vernon Car Manufacturing Co., Mt. Vernon, Ill., died in that city on October 28. Mr. Queen was well and favorably known to all cast iron car wheel manufacturers and has been superintendent of the Mt. Vernon foundry since 1902. He was born in Bardstown, Ky., in 1871. For the past two years Mr. Queen has been engaged in planning and directing the construction of the new foundry of the Mt. Vernon Car Manufacturing Co., which has been practically completed.

Albert J. Earling, at one time president, and chairman of the board of the Chicago, Milwaukee & St. Paul Railway, died on November 10 in Milwaukee, Wisc. He had been in ill health for some time. Mr. Earling was born at Richfield, Wisc., on January 19, 1848, and entered railway service with the Milwaukee & St. Paul, now in the Chicago, Milwaukee & St. Paul Railway, in 1866. He was a telegraph operator, following which he was a train dispatcher and assistant superintendent. From 1882 to 1884 he was a division superintendent and until 1888 was assistant superintendent. During the next few years he served as general superintendent and in 1890 was promoted to general manager. He held this position until 1895, when he was elected second vice-president. In 1899 he assumed the presidency of the company and remained in the position until 1917, when he retired from that position and was elected chairman of the board of directors. He retired from this position in November, 1918.

New Publications

Books, Bulletins, Catalogues, etc.

Agathon Alloy Steels by the Central Steel Co. sets forth the merits of the steels manufactured by that company. "Agathon" in the original Greek means "good," with special reference to "good in its kind," so that one is led to infer that these steels are good of their kind, which is evidently true, or at least many people must think it true, if an absorption of a half million or more tons of its product annually is to be taken as a criterion of the popular opinion on the subject. So these good (Agathon) steels have been developed in response to a demand for greater resistance to abrasion, severe shocks, strains and stresses, which has necessitated the use of various alloys such as nickel, chromium, vanadium and molybdenum. Hence these highly efficient alloy steels, in which hardness and toughness have been made to go side by side.

There are a series of diagrams illustrative of the qualities of their five grades of U. M. A. steel which are interesting and deserving of careful study. These set forth the physical properties of reduction, tensile strength, limit of elasticity, elongation and Brinell hardness are developed by different drawing temperatures. The whole treatment as well as the chemical composition of the steel being fully set forth. U. M. A., by the way, is a trade name adopted by the Central Steel Co. for a certain part of its product and is derived from the initial letters of the three cleansing ingredients used in the manufacture, namely: uranium, magnesium and aluminum.

In order to make the diagrams and what they represent quite clear one is repeated with a full explanation.

In addition to the diagrams of the U. M. A. steels, there are ten similar ones of steels made in accordance with the specifications of the Society of Automotive Engineers and three of chrome vanadium, nickel, molybdenum and chrome molybdenum steels respectively.

The catalogue closes with tables of the chemical properties of the agathon steels; a table of hardness numerals of the Brinell test; others of the weights of bar steel, of drawing bath mixtures and the decimal equivalents of the fractions of an inch in ordinary use.

Manual of Organon. By C. W. Gremple. New York, Organon Lyceum 32 pages, 4 in. by 7 in.

The title tells one that this little book treats of the philosophy and science of organing, or the art of management. Why this unusual word was used, a word that few people have ever heard, instead of the simple and intelligible expression, "The Art of Management," is difficult to tell. Unless it is intended to appeal to that class of people who are tremendously impressed by words they do not understand and jump to the conclusion that the person who uses them must be very learned.

After about a dozen pages of quotations whose connection with anything in particular is difficult to understand, we are treated to the Century Dictionary definition of "Organon," and are told that it is "an instrument of thought."

Among the authors quoted, are Herbert Spencer, Ruskin, Taylor, Sir William Hamilton, Harrington Emerson, whose sayings may have had some sense when associated with their own context, but are lost and incomprehensible here. Then, in the midst there is intercollated such dogmatic statements as: "The time has come to *re-orthodoxize* mechanical engineering," whatever that may mean. But why continue? There are four chapters and an appendix, all equally obscure, so that one wonders if even the author knows what he is trying to say. Another wonder is on what ground the publishers should expect anyone to spend good money for the purchasing of such a publication.

Cars and Car Equipment. The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has issued supplement No. 1 to volume II of Cars & Car Equipment. The new supplement is designated as Special Publication 1739. It will be recalled that in October, 1920, the Westinghouse Company published Volume I on this subject as Special Publication 1626, and in October, 1924, published Volume II as Special Publication 1714. The new supplement now available, illustrates and gives floor plan and complete weights, dimensions, ratings, and service data on the new cars of the Grand Rapids Railway Company, Detroit United Railway, Gray's Harbor Railway & Light Company, Tampa Electric Company, Fresno Traction Company, Coast Cities Railway, Honolulu Rapid Transit Company, Ltd., Mt. Carmel Transit Company, Trenton and Mercer County Traction Corp., Los Angeles Railway Corp., Philadelphia and Western Railway Company and the B. M. T. Lines—Rapid Transit Division. This publication may be obtained from the Publicity Department at East Pittsburgh or from any Westinghouse district office. If copies of the preceding volumes are desired, they also may be obtained from the same sources.

The Versare Gasoline-Electric Coach. The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has issued folder 4667, describing the operation and the electrical equipment of "The Versare Gasoline-Electric Coach." This folder, in two colors, illustrates all electrical equipment and includes a main and control circuit schematic as well as complete weights, dimensions and ratings. The Versare coach, which is 38 ft. long, will turn completely in a street 43 ft. wide. It seats 44 passengers and weighs 18,000 lb. empty. It is equipped with one Westinghouse 60 Hp. generator, two Westinghouse 28½ Hp. motors and Westinghouse hand-operated directional control, foot operated braking controller and steering column field control.

This folder may be obtained from the Publicity Department at East Pittsburgh or from any Westinghouse district office.

The Advantage of Operating New Equipment. The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has issued Leaflet 20,265 on "The Advantages of Operating New Equipment." This four-page leaflet very attractively presented in two colors, emphasizes the many disadvantages of continuing in operation obsolete equipment and the many advantages resulting from the operation of new and up-to-date cars. Obsolete equipment is not inviting to the public, while it is a proven fact that new cars attract patronage when used to provide more frequent service. They also effect large savings in operating expenses. The developments in electric railway motor and control equipment have kept pace with the development of car design so that minimum weight for given electrical capacity has been obtained. The advantages of multiple unit control are explained and it is urged that all co-operate to stamp out the idea that "the railways are through." Several typical new cars are illustrated with insets illustrating the type of equipment which has been replaced. In view of the interest the Association is taking at this time in the subject of retiring old equipment, this leaflet is of particular value. Copies may be obtained from the Publicity Department at East Pittsburgh or from any Westinghouse district office.

The 250 H. P. Gasoline Electric Car for the Reading Company. The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has issued Folder 4664, describing the operation and electrical equipment of "The 250 Hp. Gasoline-Electric Car for the Reading Company." This folder in two colors, in addition to information on performance and electrical equipment, describes the advantages of gasoline-electric equipment, illustrates the engine generator unit, gives floor plan in elevation of the car and gives complete weights, dimensions and ratings. The folder is of particular value at the present time, due to the constantly increasing interest shown in the application of gasoline-electric equipment to steam railroad branch lines. This folder may be obtained from the Publicity Department at East Pittsburgh, or from any Westinghouse district office.

Materials Handling. The Westinghouse Electric & Manufacturing Company has just issued circular 7378, on materials handling, that shows the beneficial results to be obtained in the various industries through the use of electrically driven machinery for the handling of materials. This circular contains information and data covering the principal groups of materials handling machines, giving their uses, typical outputs, and the electrical equipment best suited for their successful operation. It describes also the electrical equipment the Westinghouse company has developed for materials handling machinerty. Cranes, hoists, winches, conveyors, coal loading machines, freight elevators, trucks, locomotives and dredges are some of the types of equipment described and illustrated. This circular may be had from any of the district offices of the company or from the department of publicity at East Pittsburgh, Pa.

General Electric Steam Turbines. General Electric steam turbines rated at 500, 600 and 750 kw. are described in Bulletin GEA-235, just issued by the General Electric Company, Schenectady, N. Y. The general principles and advantages of steam turbines are discussed, and sections and steam path diagrams are shown.

The Articulated Car. The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has issued Leaflet 20,266 on "The Articulated Car of the B. M. T. Lines—Rapid Transit Division." This four-page leaflet, attractively presented in two colors, illustrates the important electrical equipment, includes the wiring diagram of the articulated car and in addition to a complete description of the motor, equipment and accessories, elaborates on the importance of this equipment as representing the latest development for rapid transit service. These new units comprise three complete subway-type bodies permanently coupled together and mounted on a total of four tracks using two Westinghouse motors each on the end trucks of the unit, together with double end multiple unit control. This leaflet may be obtained from the Publicity Department at East Pittsburgh or from any Westinghouse district office.